Ecosystem Management Decision Support (EMDS) Summary of Fiscal Year 2011 Results

2011

June 2010

Prepared for the National Wildfire Coordinating Group Interior Fuels Management Committee

U.S. DEPARTMENT OF THE INTERIOR

BLM/OC/ST-11/004+9217

Johnson, R., G. Barnes, K. Gollnick-Waid, J. Wallace, A. Bundshuh, S. Goodman, and Jerry Szymaniak. 2011. Ecosystem management decision support (EMDS): Summary of fiscal year 2011 results. Prepared for the National Wildfire Coordinating Group Fuels Management Committee. BLM/OC/ST-11/004+9217. U.S. Department of the Interior, Bureau of Land Management, Denver, CO.

Editing, layout, and design were provided by the BLM National Operations Center, Information and Publishing Services Section.

U.S. DEPARTMENT OF THE INTERIOR

Ecosystem Management Decision Support (EMDS) Summary of Fiscal Year 2011 Results

2011

JUNE 2010

Prepared for the National Wildfire Coordinating Group

Interior Fuels Management Committee

By

U.S. Department of the Interior Fuels Decision Support Subcommittee

Chair:

U.S. Department of the Interior,
Office of Wildland Fire Coordination
Russell Johnson

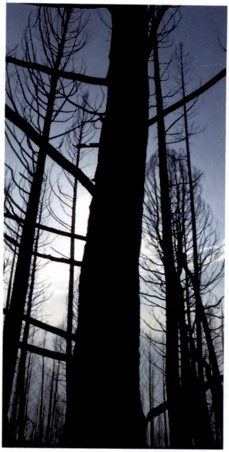
Subject Matter Experts:

Bureau of Indian Affairs
Gerald Barnes
Bureau of Land Management
Krista Gollnick-Waid
U.S. Fish and Wildlife Service
Jon Wallace
National Park Service
Andy Bundshuh

Analysts:

Bureau of Land Management
Susan Goodman
U.S. Fish and Wildlife Service
Jerry Szymaniak

Contents



Appendix 3 Figures

Tables

Appendix 5 Tables

Acknowledgments

The Fuels Decision Support Subcommittee (FDSSC) gratefully acknowledges the support and intellectual contributions of the following persons, who helped complete the Fiscal Year 2011 (FY 11) Department of the Interior (DOI) Ecosystem Management Decision Support (EMDS) analysis:

Dr. Keith Reynolds, with the U.S. Forest Service (USFS) Pacific Northwest Research Station (Corvallis, Oregon), is the leading expert in EMDS, supports USFS EMDS analyses, and served as a consulting analyst in the FY 11 DOI effort. Dr. Reynolds' insights, counsel, participation, and support continue to set an exemplary standard for interagency cooperation and were indispensable to the DOI FY 11 EMDS analysis.

Mr. James Menakis, with the USFS Fire Modeling Institute at the Missoula Fire Sciences Laboratory in Montana, conducts USFS EMDS analyses and served as a consulting analyst in the FY 11 DOI effort. He provided substantive advice regarding source data sets and modeling considerations. His advice about integrating a new approach to modeling Wildfire Potential was particularly important, and his engagement overall helped achieve increased commonality with USFS EMDS efforts.

Mr. Skip Edel and Mr. Dave Hammond of the National Park Service assisted FDSSC analysts with GIS (Geographic Information System) work and map graphics production.

Ms. Susan Guthrie of Northrop Grumman (contractor to the Bureau of Land Management) provided key support in Fire Planning Unit boundary rectification and map graphics preparation.

Ms. Ethel Coontz, with the Bureau of Land Management (BLM), National Operations Center (NOC), performed the design and layout of this publication; Ms. Nancy Esworthy at the NOC provided editorial support.

Executive Summary

The Fiscal Year 2011 (FY 11) Ecosystem Management Decision Support (EMDS) analysis, directed by the Department of the Interior (DOI) Office of Wildland Fire Coordination (OWFC), was delegated by the DOI Fire Directors to the National Wildfire Coordinating Group (NWCG) Interior Fuels Management Committee (IFMC). The analysis is intended to provide decision support to ensure that funds are directed to the highest priority projects in the highest priority areas and that they complement the activities of neighboring States, tribes, and local partners. As in previous analyses, the IFMC tasked an interagency team to assemble and review data and to recommend improvements to the IFMC with respect to data and model structure. This team—impaneled as the IFMC's Fuels Decision Support Subcommittee (FDSSC)—then conducted the FY 11 analysis with IFMC concurrence and with significant consultation provided by key U.S. Forest Service (USFS) staff.

Consistent with the restructuring of the DOI Hazardous Fuels Prioritization and Allocation System (HFPAS) to bring decision support closer to the landscape and inform treatment-level prioritization, the FY 11 EMDS analysis implemented fundamental changes that constitute a new baseline for DOI analyses. For example, the FY 11 analysis considered all DOI lands at a Fire Planning Unit (FPU) level—in contrast with the Bureau-specific focus of prior analyses. In addition, the FY 11 analysis investigated both legacy and new, simulation-based approaches to assessment of Wildfire Potential (WFP). Further, the FY 11 EMDS model relied on only two major elements: (1) Wildfire Potential, and (2) Negative Consequences from Wildfire (Human Impacts and Ecosystem Impacts). This model supports the purposes of hazardous fuels treatments: to reduce risks to firefighters and the public while reducing wildfire suppression costs.

For FY 11, as in previous years, incremental improvements have been achieved in data and methodology, and in consistency (when appropriate) with USFS sources and methods. Although "stability" is an ultimate goal for EMDS and the HFPAS process, the fundamental changes made for FY 11 necessarily constitute a new baseline for DOI analyses. In the near term, tradeoffs may continue to be required between consistency of successive models, on the one hand, and the incorporation of fundamental base data revisions (with model accuracy implications) and evolutionary model improvements, on the other hand. For the future, the FDSSC envisions and recommends using an Operations and Maintenance (O&M) concept, with a relatively stable EMDS model structure and analysis units, which will support long-term fuels management planning.

This report describes the geospatial data and modeling approach used in the FY 11 EMDS analysis to assess and prioritize DOI hazardous fuels by FPU, presents the results of the analysis, and offers recommendations for future EMDS analyses, with highlights as follows:

Deliverables and Innovations:

- A prioritized list and maps of CONUS FPUs based on all DOI lands
- Incorporation of Large Fire Simulator data (produced by the USFS Missoula Fire Sciences Laboratory under Fire Program Analysis [FPA]) funding to assess Wildfire Potential
- Stratification of Wildland Urban Interface by fire potential
- Incorporation of critical infrastructure
- Development of an ecosystem vulnerability matrix

Key Findings:

- Technical options exist to improve the performance of the EMDS model, but adequate time will be required to develop and implement them.
- A substantially "new" DOI EMDS analysis for FY 12 cannot be delivered before September 2011, and would also require action on FDSSC staffing arrangements. Any requirement for EMDS results before then must substantially rely on the FY 11 analysis.

Key Recommendations:

- Before stabilizing DOI EMDS modeling, senior management should evaluate whether adequate balance has been achieved between current model quality and analysis objectives.
- Consistent, formal EMDS staffing and project management should be developed, and the supporting infrastructure should be improved.
- As a critical step to support validation, continuity, and stability (especially as staffing evolves), DOI EMDS process documentation should be developed to serve as technical reference material.
- As part of the basis for decisions on EMDS stabilization, senior management should assess EMDS capabilities and purpose in the context of the status and direction of major DOI enterprise programs, such as FPA, LANDFIRE, the National Fire Plan Operations and Reporting System (NFPORS), and others.
- To facilitate *both* stability *and* improvement, DOI EMDS should evolve toward an Operations and Maintenance (O&M) concept and embrace lifecycle management principles.

This report presents a DOI interagency consensus by the FDSSC that is consistent with congressional and DOI policies and directives, to the extent that these can feasibly be modeled and evaluated using available geospatial data in an FPU-based framework. The results presented in this report constitute a key component in the overall HFPAS process.

Introduction

Treatment of hazardous fuels is intended to reduce risks to firefighters and the public and to lower the costs of wildfire suppression. The Ecosystem Management Decision Support (EMDS) model for Fiscal Year 2011 (FY 11) is structured to identify and prioritize areas for application of fuels treatments based on two major model elements: (1) Wildfire Potential (WFP), and (2) Negative Consequences from Wildfire (Human Impacts and Ecosystem Impacts).

Since the National Fire Plan was adopted in 2001 the U.S. Government Accountability Office and the Office of Management and Budget have regularly expressed concern or issued direction regarding the need for logical, clear, and consistent processes for the allocation of hazardous fuels funds in the Department of the Interior (DOI) and U.S. Department of Agriculture's Forest Service (USFS).[1] Congress has expressed similar concerns regarding the DOI allocation process affecting the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), the U.S. Fish and Wildlife Service (USFWS), and the National Park Service (NPS) (hereinafter collectively referred to as the DOI Bureaus) and Bureau regions. Along with USFS, DOI has responded to these concerns during the past several years by using the EMDS system and process to analyze and display geographically the national and regional priority areas for hazardous fuels treatments for the DOI Bureaus.

EMDS is a knowledge-based system that uses tabular and geospatial information. EMDS helps managers evaluate landscapes and assists organizations in prioritizing criteria and areas for planning and budgets. DOI has continued to employ EMDS to support FY 11 hazardous fuels funding allocation decisions (as has USFS), incorporating modifications from the FY 10 approach as required to support the restructured DOI FY 11 Hazardous Fuels Prioritization and Allocation System (HFPAS) process. EMDS results will be considered by decision makers as one of several structured steps within the DOI FY 11 HFPAS process.

[1] See, for example, U.S. Government Accountability Office, "Wildland Fire Management: Better Information and a Systematic Process Could Improve Agencies' Approach to Allocating Fuel Reduction Funds and Selecting Projects," Highlights of GAO-07-1168, Report to Congressional Requesters, September 2007; *www.gao.gov/highlights/d071168high.pdf.*

Ecosystem Management Decision Support (EMDS) Model Description and Analytical Components

The EMDS system is a computer-based framework for knowledge-based decision support of ecological assessments at any geographic scale. EMDS integrates state-of-the-art Geographic Information System (GIS) data with knowledge-based reasoning and decision modeling.[2] EMDS evaluates landscape conditions by using the NetWeaver logic engine, and it evaluates associated management priorities by using Criterium Decision Plus (CDP), a decision modeling engine.

NetWeaver allows partial evaluations of ecosystem states and processes based on available information. This capability makes NetWeaver ideal for use in landscape evaluation, where data are often incomplete, and it readily supports analysis of large, complex, and abstract problems typically posed by ecosystem management. CDP is an agreed upon set of rules for scientific inquiry to help users make complex decisions among alternatives involving multiple criteria. CDP also includes sensitivity analysis tools to aid in understanding the relationship among model inputs, model weights, and robustness of outputs.

The FY 11 DOI EMDS analysis was conducted on CONUS Fire Planning Units (FPUs) based on Wildfire Potential (WFP) and Negative Consequences elements defined in a logic model. CDP was employed to integrate DOI lands data by both area and proportion for all model inputs.

[2] See *http://www.institute.redlands.edu/emdsbeta/aboutemds/tabid/56/default.aspx.*

DOI FY 11 EMDS Model Overview

Chapter II

The DOI FY 11 EMDS project began with FDSSC data research, review, and initial preparation (for an FPU-based analysis), followed by development of a modeling approach and structure that were presented to the Interior Fuels Management Committee (IFMC) of the National Wildfire Coordinating Group (NWCG) for concurrence. In consultation with the IFMC, and based on the direction and approval of the DOI Fire Directors, the final DOI FY 11 EMDS model was established. This model is shown in Figure 1; more details about the WFP modeling approach are presented in Figures 2 and 3.

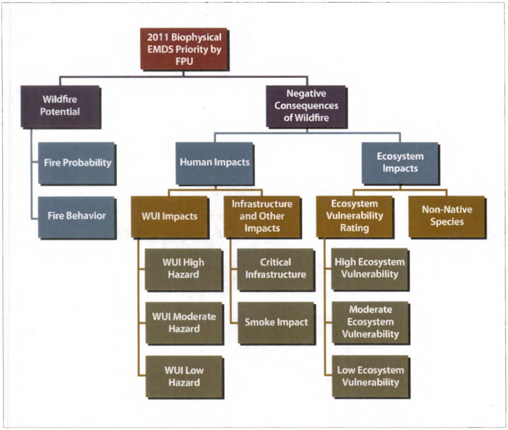
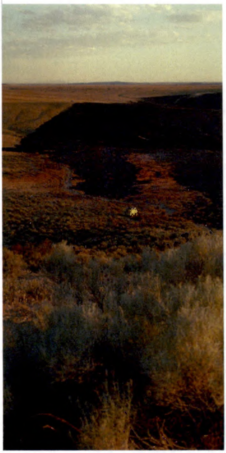


Figure 1. Final DOI FY 11 EMDS Model, Element Overview



References to top-level, broad criteria used in this report and shown in Figure 1 as Wildfire Potential and Negative Consequences (purple boxes) will be referred to as "elements." "Sub-elements" (blue boxes) are the next tier—subordinate, more specific model criteria that logically contribute to and hierarchically fall within the respective elements. Model components below this level (orange boxes) will be referred to as "nodes," and the lowest tier (green boxes) as "inputs" or "data" as appropriate.

The DOI FY 11 EMDS tasking required investigation of two, alternative technical approaches for WFP: the DOI "legacy" approach used in previous EMDS analyses, based on historical fire data from DOI enterprise systems and on LANDFIRE fuels data; and a new approach based on data from the Large Fire Simulator (LFS), sourced from the USFS Missoula Fire Sciences Laboratory (MFSL) and funded by the Fire Program Analysis (FPA) project. Diagrams of these respective modeling approaches for the WFP element for FY 11 are shown in Figures 2 and 3.

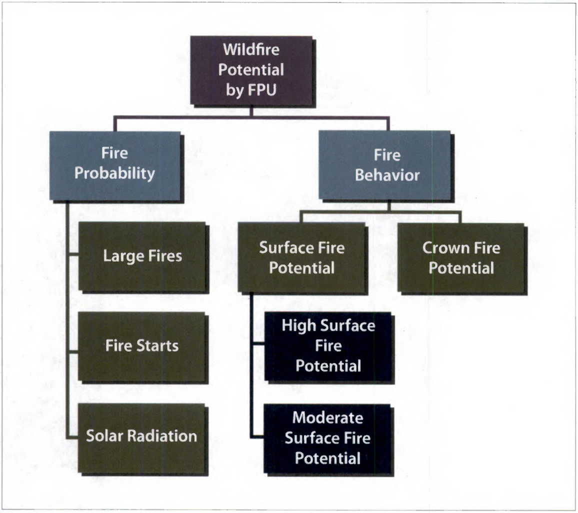


Figure 2. WFP EMDS Element, DOI Legacy Method

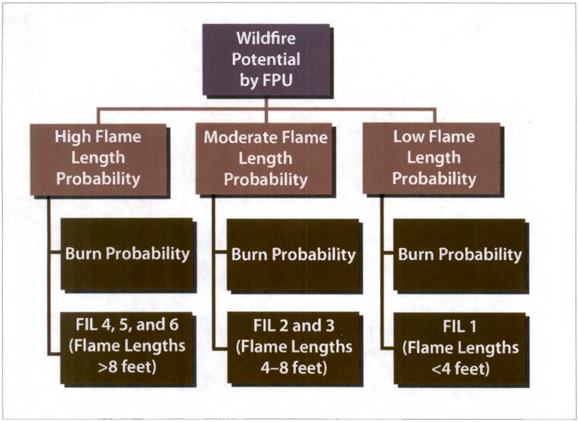


Figure 3. (Revised) WFP EMDS Element, LFS Method

Note: DOI employed the same LFS data set and modeling approach in its LFS-based model as did the USFS FY 11 EMDS analysis. The identical Negative Consequences element shown in Figure 1 was employed to generate the overall DOI FY 11 EMDS model results with each WFP approach.

In addition to approving the proposed data sources and modeling approach, the DOI Fire Directors approved the model weights, as summarized in Table 1 (note that WFP and Negative Consequences elements were coequally weighted in the FY 11 analysis).

Table 1. FY 11 DOI EMDS Model Structure and Influence/Weight Summary

Elements	Wildland Fire Potential (WFP) Large Fire Simulator (LFS) Alternative	Fire Directors' Influence/Weights	WFP Legacy Alternative	Fire Directors' Influence/Weights
Wildfire Potential = 0.50 Total				
			Fire Probability = 0.25 Total	
	Probability of High Flame Length	0.280	# of Large Fires	0.080
	Probability of Moderate Flame Length	0.140	# of Fire Starts	0.080
	Probability of Low Flame Length	0.080	Area with High Solar Radiation	0.060
			Area with Moderate Solar Radiation	0.030
			Fire Behavior = 0.25 Total	
			Area with High Surface Fire Potential	0.100
			Area with Moderate Surface Fire Potential	0.050
			Area with Low Surface Fire Potential	0.000
			Area with Crown Fire Potential	0.100
Note: Negative Consequences Element/Structure is the same for either WFP alternative				
Negative Consequences = 0.50 Total				
Human Impacts = 0.25 Total				
	WUI = 0.1875			
	Area with WUI and High Fire Hazard	0.094		
	Area with WUI and Moderate Fire Hazard	0.063		
	Area with WUI and Low Fire Hazard	0.031		
	Critical Infrastructure and Other Impacts = 0.0625			
	Area with Critical Infrastructure	0.031		
	Area with Smoke Impacts	0.031		
Ecosystem Impacts = 0.25 Total				
	Ecosystem Vulnerability Rating = 0.2125			
	Area with High Ecosystem Impacts	0.106		
	Area with Moderate Ecosystem Impacts	0.071		
	Area with Low Ecosystem Impacts	0.035		
	Non-Native Species = 0.0375			
	Area with Non-Native Species	0.038		
Total Weight		1.000		

After considerable efforts were made to rectify FPU boundaries and ensure use of the most current land status information from the DOI Bureaus, input data were summarized for all agency lands by both total DOI area in an FPU and DOI proportion of an FPU area—an approach deemed necessary through FDSSC investigation and consensus (with IFMC approval) to conduct a credible national assessment on FPUs of greatly varying size, DOI presence, and biophysical characteristics. Data inputs and summarization are further described in Chapter III and Appendix 1. Model runs were conducted in accordance with the model weights approved by the Fire Directors, as shown in Table 1.

As in previous years, the analyses were limited to CONUS, owing to limitations in availability or timeliness of suitable data (for example, LANDFIRE data for Alaska). Sensitivity analysis was conducted for final model runs.

As noted earlier, the approach to the FY 11 EMDS analysis constituted a fundamental departure from previous efforts and a new baseline for DOI. Key technical differences from the FY 10 model included: (a) 136 CONUS FPUs employed as units of observation; (b) joint assessment of all DOI lands, instead of Bureau-specific analysis; (c) logic model–based assessment using Wildfire Potential (WFP) and Negative Consequences elements only;[3] (d) concurrent evaluation of WFP based on DOI legacy techniques and the LFS-based approach; and (e) categorization of results in 10, rather than 5, priority classes.

[3] Additional elements considered in prior analyses were to be addressed elsewhere in the FY 11 HFPAS process.

DOI FY 11 EMDS Data Source Details and Summary

This section provides an overview of data sources and preparation at the element and sub-element levels in the DOI FY 11 EMDS model. Note that unless otherwise specified, all data were summarized and input by both total area and proportion, as previously described. Greater detail for all model input data may be found in Appendix 1. Description of LANDFIRE versions used in this report may be found on the LANDFIRE Web site.[4]

1. WFP Element, DOI Legacy Method

As diagrammed previously in Figure 2, the NetWeaver logic engine was employed to characterize WFP conditions based on Fire Probability and Fire Behavior sub-element data. Inputs for these sub-elements were as follows:

A. Fire Probability

Large Fires—Large Fire reporting data were downloaded from the Wildland Fire Management Information System (WFMI) and from FWS's Fire Management Information System (FMIS) database. Counts for fire types 11–23 and 49 were used, and, as in previous analyses, Large Fires were defined as 100 or more acres in forested areas and 300 or more acres in non-forested areas. In the FY 11 analysis, determination of "forest" was based on a forest mask derived from LANDFIRE Existing Vegetation Type (EVT) tree life form (circa 1999–2003, LF_1.0.0).

Fire Starts—Fire reporting data for the Bureau of Indian Affairs (BIA), the Bureau of Land Management (BLM), and the National Park Service (NPS) were also downloaded from WFMI and FMIS. Total fire counts were used for fire types 11–23 and 49 for the years 2000–2009.

Solar Radiation—A CONUS national data set was developed by the U.S. Department of Energy's National Renewable Energy Laboratory (NREL)

[4] See *http://www.landfire.gov/version_comparison.php.*

based on measurements collected in 1998–2005. The highest categories of incident solar radiation were extracted and summarized. The data and approach were consistent with the FY 10 DOI EMDS analysis.

B. Fire Behavior

Surface Fire Potential (SFP)—LANDFIRE Scott and Burgan Fire Behavior Fuel Models (FBFM) 40 data were used for SFP, with moderate and high categories developed and weighted analogously with the CFP approach described below. Determination of low to high SFP was based on a BEHAVE Plus run of a typical fire day using calibrated FBFM 40 data from the LANDFIRE data set version LF_1.0.2, current as of August 2009 (calibrated fuels subset used).

Crown Fire Potential (CFP)—Owing to quality issues with the FY 10 approach, the FY 11 CFP was assessed based on spatial co-occurrence of moderate and high SFP classes with closed conifer canopy, based on LANDFIRE EVT data and Existing Vegetation Cover data.

Note: Owing to quality issues with available data and scale-suitability for an FPU-based analysis, an Insect and Disease component was not included for FY 11.

2. WFP Element, LFS Method

Wildfire Potential was calculated for the FY 11 analysis based on data outputs from the LFS model developed by Dr. Mark Finney at the USFS Missoula Fire Sciences Laboratory.[5] An important characteristic of the LFS is that it models all types of fire spread (crown, head, flanking, and backing fires), whereas the DOI legacy method incorporates fire spread and intensity only at the head of a fire. The LFS Burn Probability (BPR) layer was used in conjunction with the LFS Fire Intensity Level (FIL) layers. Note that WFP was mathematically computed at the element level (as described below); there are no logic model sub-elements in this approach.

BPR considers historical fire occurrence over a simulated range of fire seasons. This layer is produced with the same modeling approach as that used by Dr. Finney in his Fire Spread Probability (FSPRO) model.6 (The primary difference between FSPRO and LFS-BPR is that random ignitions are modeled based on historical

---

[5] Finney, M., "Simulation of Burn Probabilities and Fire Size Distributions for the Western United States," Geophysical Research Abstracts, vol. 11, EGU2009-6544, 2009 (available at: *http://meetingorganizer.copernicus.org/EGU2009/EGU2009-6544.pdf*); Finney, Mark A., "A Prototype Simulation System for Large Fire Planning in FPA," July 5, 2007, Report, Missoula, MT (available at: *http://www.fpa.nifc.gov/Library/Docs/Science/FPA_SimulationPrototype_0705.pdf*); and Finney, Mark, Isaac C. Grenfell, and Charles W. McHugh, "Modeling Containment of Large Wildfires Using Generalized Linear Mixed-Model Analysis," Forest Science, 55(3):249–55(7).

[6] Ibid.

fires in the LFS, whereas actual ground ignitions are used to predict probabilities of a pixel burning in FSPRO.)

LFS FIL data consist of layers providing conditional probabilities. FIL predicts the probability of occurrence of a flame length class for a pixel, given that the pixel burns (that is, that the pixel also has a non-zero value in the BPR layer). FIL is expressed in incremental classes running from lowest to highest flame lengths and labeled FIL1–FIL6. Based on fuels present, each pixel may have multiple FIL conditional probabilities that sum to a total of one for each pixel.

WFP was mathematically computed as the product of BPR and FIL layers, using the ArcMap spatial analyst extension and, as illustrated in Figure 4, resulting in a raster file providing a flame length–weighted WFP estimate for each pixel.

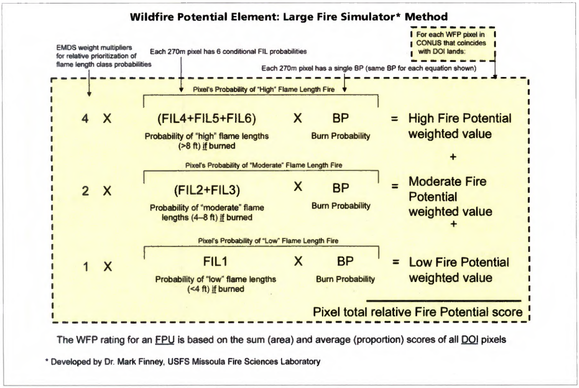


Figure 4. Method for Mathematical Computation of WFP EMDS Element, LFS Method

This approach was implemented in coordination with the FY 11 USFS EMDS analysis, which employed the same LFS data set and an analogous WFP computation.

3. Negative Consequences

The Negative Consequences model element reflects key potential impacts of wildfire. The element was defined consistently, irrespective of which WFP approach would ultimately be used, and was composed of Human Impacts and Ecosystem Impacts sub-elements as follows:

A. Human Impacts

Wildland Urban Interface (WUI) Impacts—A populated and developed area base layer was compiled from four sources to estimate and represent WUI: (1) the FPA WUI layer, which is a 2-km buffered derivative product of the WUI layer of the SILVIS Lab at the University of Wisconsin (circa 2001); (2) the National Oceanographic and Atmospheric Administration (NOAA) satellite-derived Night Lights data set (circa 2008), where there was no co-occurrence with FPA's SILVIS data (thresholded to exclude low intensities not correlated with known WUI locations, and unbuffered owing to course spatial resolution); (3) the LandScan data set from Oak Ridge National Laboratory (circa 2006), where there was no co-occurrence with the previous two sources (buffered by 1 km); and (4) a nationwide NPS structures data set (circa 2009), where there was no co-occurrence with any other WUI data source (buffered by 1 km). FPA's SILVIS product was supplemented with the other sources to make the resulting composite layer a more current representation of the landscape for the FY 11 analysis and to improve the accuracy of WUI representation in lower density, intermixed areas. The NPS data set, in particular, was employed to fill gaps in other WUI sources that are highly correlated with NPS lands owing to transient population and the absence or deliberate suppression of night lighting in these areas. Use of this final source ensured proper ranking of FPUs where NPS lands constitute the predominant DOI presence.

The WUI composite data were then stratified into low, moderate, and high classes using the SFP categories defined for the legacy WFP method previously described. Moderate WUI received twice the weight of low WUI; high WUI, three times the weight of low WUI in modeling WUI impacts.

Note: When interpreting WUI at this level and its influence at higher levels of the model, it is critical to bear in mind that the model considers co-occurrence of WUI with DOI lands—not just WUI presence and distribution generally by FPU.

Infrastructure and Other Impacts—This model node comprised Critical Infrastructure Impact and Smoke Impact logic model components.

Critical Infrastructure. Key data themes of interest were extracted from the National Geospatial Agency (NGA) Homeland Security Infrastructure Program (HSIP) Gold data set

(2006) and buffered. These included interstate, Federal, and State highways; railroad lines; communications and navigation antenna sites; and selected energy infrastructure locations.

Note: When interpreting results at this level and the influence at higher levels of the model, it is critical to bear in mind that, for modeling purposes, these areas were included where they occurred outside WUI areas already defined.

Smoke Impact. Considering the FPU-based scale and prioritization framework for the FY 11 analysis, Smoke Impact areas were defined by focusing on where people are most likely to be negatively affected—that is, within 5 miles of the WUI.

Note: The Fire Directors requested evaluation of a 10-mile buffer, which was found to result in too little discrimination between FPUs CONUS-wide. For similar reasons, even the 5-mile buffer (and the general approach to assessing Smoke Impact) should be revisited in future analyses (see recommendations in Chapter V).

B. Ecosystem Impacts

Ecosystem Vulnerability Rating—To improve previous approaches keyed only to Fire Regime Condition Class (FRCC), the FDSSC developed and the IFMC helped finalize a matrix for assigning low- , moderate- , and high-impact categories by concurrently considering life form, FRCC, and fire return intervals. The approach was based on LANDFIRE data layers (LF_1.0.0) consisting of EVT (for life form), FRCC, and Fire Regime Group (FRG) (for fire return interval). Moderate ecosystem vulnerability areas received twice the weight of the low category, and high ecosystem vulnerability areas received three times the weight of the low category. The Ecosystem Vulnerability Matrix may be found in Appendix 2.

Non-Native Species—LANDFIRE (LF_ 1.0.0) non-native EVT classes and invasive Successional Class (S-Class) data were used for this model component in FY 11, as in the FY 10 model.

DOI FY 11 EMDS Results and Sensitivity Analysis

Chapter IV

This chapter compares the results obtained from using legacy and LFS-based approaches to WFP assessments for the DOI FY 11 EMDS analysis, and it describes the resulting IFMC recommendation and Fire Directors' decision to employ the LFS approach. Negative Consequences and overall model results are described next, followed by a sensitivity analysis for the finalized model. Alternative overall results and logic model component results below the element level are provided in Appendix 3.

The model FPU scores and the 10 categories shown in the map graphics range from 0 to 1 and may be interpreted as the degree to which an FPU approaches the maximum possible rating at a given level of the model. Uncategorized, raw model results for the FPUs may be found in Appendix 4.

Note: Unless otherwise indicated, FPU map graphics in this report are rendered with a color key based on quantile breaks. This method of dividing the data range of the results places an equal number of FPUs in each of the requisite 10 priority categories, providing a consistent means to review and compare maps with differing data ranges.

1. Legacy and LFS WFP Element Methodology Comparison, Results, and Decision

As described above, the FDSSC was tasked with exploring DOI's legacy and LFS-based methods of creating the WFP model element. Figures 5 and 6 , respectively, reflect the results for the WFP element using these two approaches.

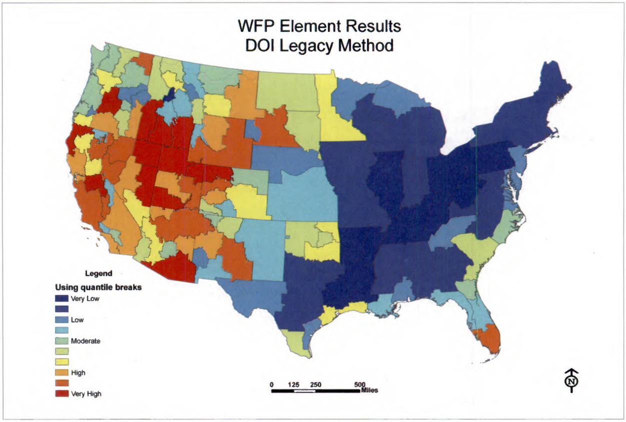


Figure 5. WFP Element Results, DOI Legacy Method

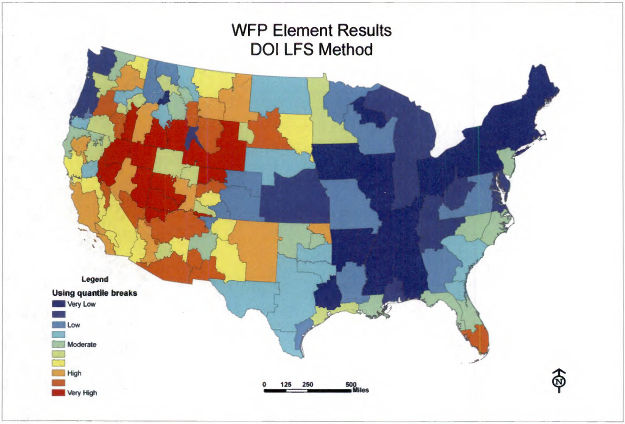


Figure 6. WFP Element Results, DOI LFS Method

The FDSSC found the respective WFP results to be qualitatively very similar. To permit a more quantitative comparison, the FPU scores from each method were reclassified into 10 integer category "bin" numbers, and the resulting legacy WFP FPU category numbers were subtracted from the LFS WFP category numbers. The resulting "bin shift" map is shown and described in Figure 7.

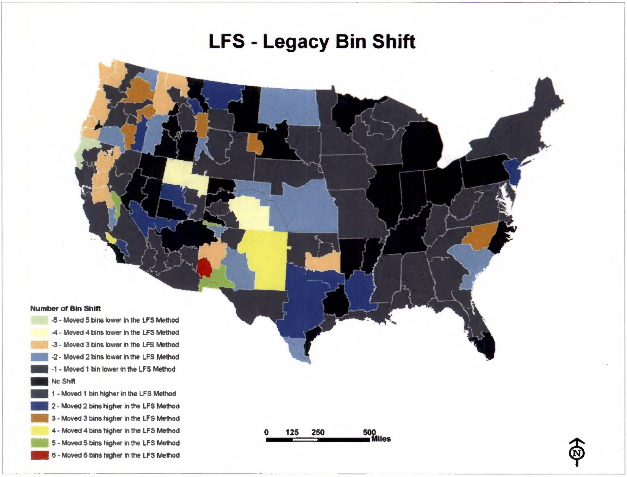


Figure 7. Difference Map of LFS and Legacy WFP Element Results

In Figure 7 saturated colors indicate higher LFS comparative category ranking, and pastel colors indicate higher legacy comparative category ranking to the degree indicated. Black indicates no category ranking difference between the two methods. Gray indicates generally indeterminate difference (within 1 bin) in category rankings between the two methods.

The legacy WFP method yielded slightly (but not significantly) higher priority scores (1–3 percent of FPUs) in the aggregate. Further analysis indicates that 31 percent of the 136 FPUs exhibited zero change, or a negligible change (that is, a single bin shift owing only to a shift between the last and first FPUs in successive categories). An additional 33 percent of FPUs showed a single rating category shift. In other words, 64 percent of FPUs ranked within the same category or within one category by each method. Overall, 81 percent of all FPUs fell within a two-rating category range between the two methods. The FDSSC and

the IFMC concluded that the respective methods, in general, were mutually corroborating national representations of DOI lands by FPU.

Cursory consideration of explanatory factors for outliers in this difference analysis focused on weather station influence within the LFS, and fire occurrence and surface versus crown fire influences within the legacy method. Given the credible and mutually supportive results of the two WFP methods, more rigorous analysis of the technical factors causing differences between the WFP results were beyond the scope and schedule of the FY 11 effort. Such an analysis, however, could yet be undertaken, consistent with the Fire Directors' decision described below.

The FDSSC consensus recommendation to the IFMC was to employ the LFS methodology for assessing WFP in the final FY 11 DOI EMDS model, based on the following considerations: there is substantial consistency between LFS and the legacy method on which the DOI EMDS has relied since FY 07 for assessing WFP; use of the LFS method would be consistent with the USFS FY 11 approach; LFS is based on peer-reviewed science; and LFS will be subject to continuous improvement, such as future incorporation of gridded weather. The IFMC made the same consensus recommendation to the DOI Fire Directors, accompanied by the comparative rationale shown in Table 2.

Table 2. IFMC Rationale for Recommending the LFS Method of Assessing WFP

LFS WFP	Legacy WFP
Is consistent with Forest Service methodology	
Incorporates actual weather data for modeling fire behavior	Assumes one fuel moisture scenario and a fixed wind speed across the nation
Uses mathematical computations to develop probabilities of individual pixels burning and flame lengths associated with those pixels burning	Combines multiple elements to produce an inferred probability on an FPU basis
Considers all types of fire behavior (heading, crowning, flanking, and backing) that may affect a given pixel when determining the flame length and burn probability for that pixel	Models head fire only
Includes influence of topography to determine fire probability and fire behavior	Does not adequately consider topography
Has more potential to improve fire behavior modeling in the future through, for example, use of gridded weather data	

The DOI Fire Directors concurred with this recommendation, provided that the DOI legacy WFP method continues to serve as a baseline and cross-check for future application of the LFS approach.

Accordingly, the final overall EMDS model for FY 11 (and the main results shown in this report) are based on LFS WFP. Legacy WFP-based results may be found, along with other model component graphics, in Appendix 3.

2. Negative Consequences Results

Based on the decision to use LFS-based results for the WFP element in the FY 11 DOI EMDS analysis, the final model result incorporated the equally weighted Negative Consequences element results, shown in Figure 8.

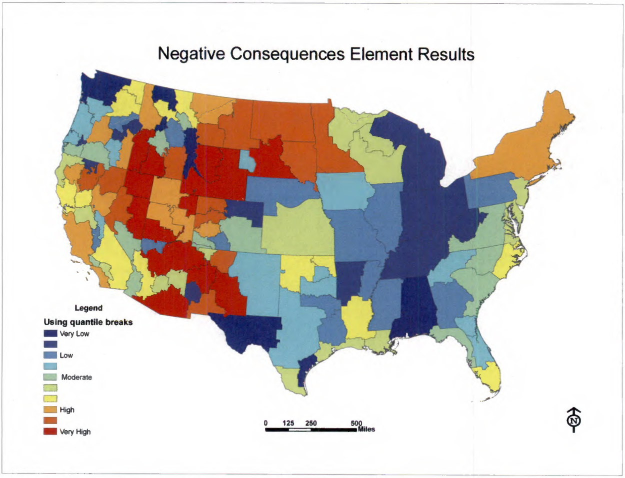


Figure 8. Negative Consequences Element Results

3. Overall Results

The overall DOI FY 11 EMDS results, considering LFS-based WFP and Negative Consequences, are shown in Figure 9 (in quantile breaks for comparison with previous maps).

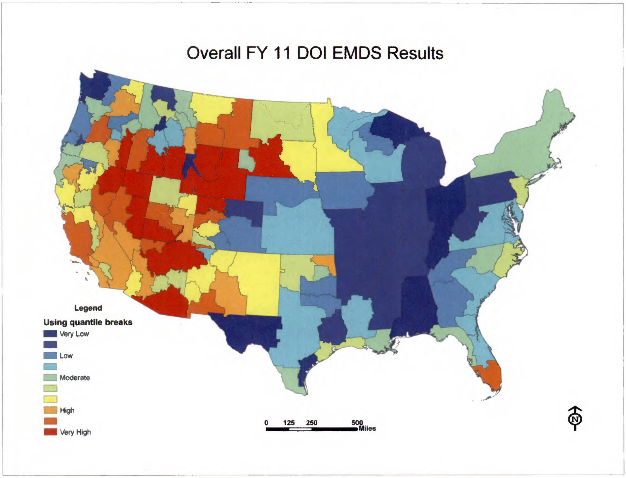


Figure 9. Overall FY 11 DOI EMDS Results (quantile breaks)

For the FY 11 DOI HFPAS process, categorized EMDS results were to be integrated with field-defined treatment categories for prioritization purposes. To support this application, and considering the distribution of raw EMDS FPU scores, the IFMC decided to define the requisite 10 FPU priority categories by applying natural breaks (rather than quantile breaks) to the EMDS results. Natural breaks establish categories based on the inherent distribution of the data, with FPUs grouped into 10 categories based on similarity of scores—resulting in different numbers of FPUs in categories (rather than the equal number of FPUs per category defined by quantile breaks). Figure 10 shows a bar graph of the raw FPU score distribution and illustrates the difference between quantile and natural breaks. Figure 11 displays the overall DOI FY 11 EMDS results using natural breaks.

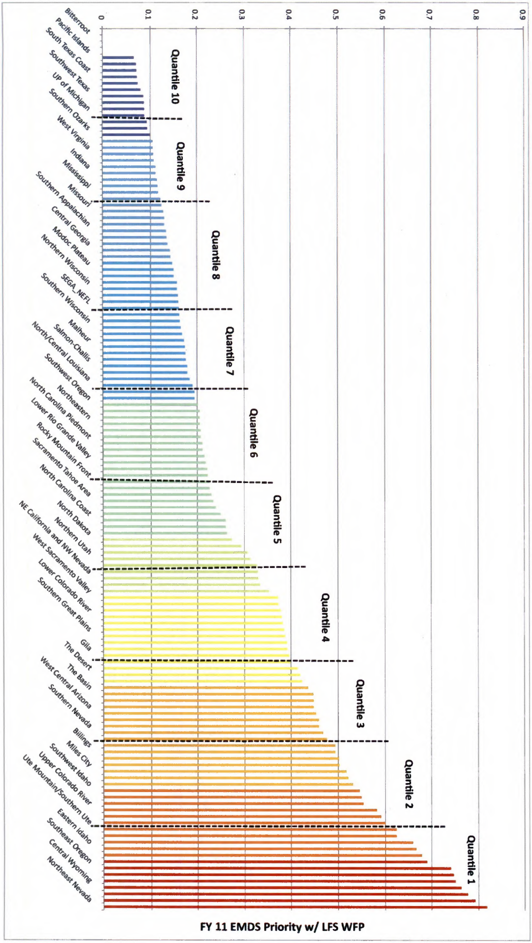


Figure 10. Ranked CONUS FPUs (136 total), Categorized by Both Natural and Quantile Breaks

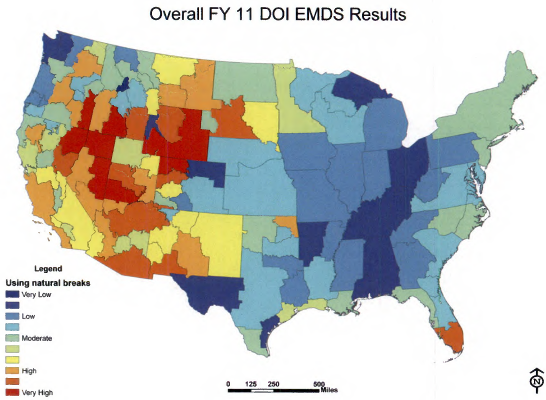


Figure 11. Overall FY 11 DOI EMDS Results (natural breaks)

4. Sensitivity Analysis

As in previous DOI EMDS analyses, native sensitivity analysis capability within the EMDS (CDP) software was used to generate tabular information showing most sensitive criteria, degree of change required to alter ranking, and the observation unit (FPU in this case) that would assume top rank were the sensitive criteria changed to the specified degree. These tables and related information are presented in Appendix 5.

A. Scatter Plot Analysis of Model Component Contributions

Considering the challenges and limitations presented by the native EMDS sensitivity analysis tables, an alternative view of model sensitivity was obtained. Generation of scatter plots and linear regression lines provided insight into contributions and potential correlation of model components to the overall model results. In general (with the exception of WUI Impacts), a

uniformly positive relationship was found between lower-level model components and overall results, with increased correlation shown when lower-level components (for example, nodes and sub-elements) were aggregated through successively higher model components (for example, elements).

Scatter plots for the lowest available logic model components and the two model elements (WFP and Negative Consequences) are shown in this chapter. It may be useful to refer to the overall EMDS model shown in Figure 1 when reviewing these scatter plots. As in previous map graphics, the scatter plot variables have valid data ranges running from 0 to 1, which may be interpreted as the degree to which an FPU approaches the maximum possible rating at a given level of the model.

LFS WFP Element—LFS-based WFP was mathematically computed according to the calculation described in Chapter III, Section 2, instead of being derived from lower-level model components. The WFP element–level results were plotted against final model prioritization results. A strong correlation ($R^2 = 0.92$) was found between the LFS element and overall model results, as shown in Figure 12.

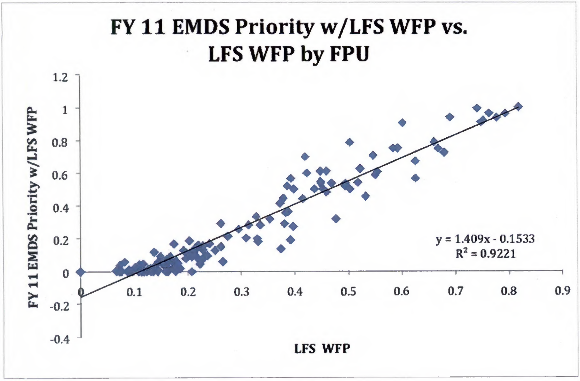


Figure 12. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and LFS WFP Element

Ecosystem Vulnerability Node. This node was one of two components of the Ecosystem Impacts sub-element within the Negative Consequences portion of the FY 11 model, as described in Chapter III, Section 3.B. The Ecosystem Vulnerability criterion was plotted against final model prioritization results. A moderate correlation (R2 = 0.63) was found with overall model results, as shown in Figure 13.

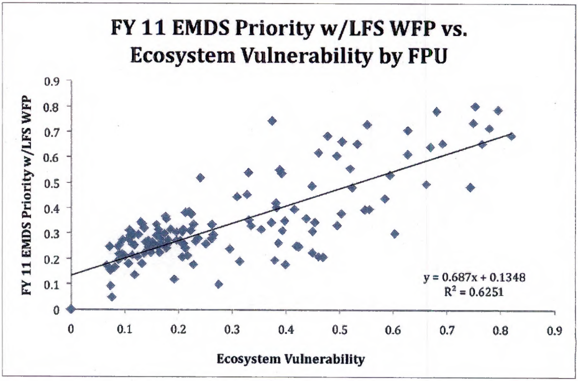


Figure 13. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and Ecosystem Vulnerability Node

Non-Native Species Node. This node was the second of two components of the Ecosystem Impacts sub-element within the Negative Consequences portion of the FY 11 model, as described in Chapter III, Section 3.B. The Non-Native Species criterion was plotted against final model prioritization results. A moderate correlation ($R^2 = 0.50$) was found with overall model results, as shown in Figure 14.

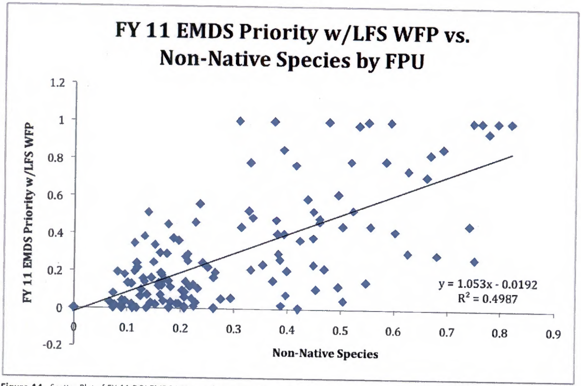


Figure 14. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and Non-Native Species Node

Infrastructure and Other Impacts Node. This node was one of two components of the Human Impacts sub-element within the Negative Consequences portion of the FY 11 model, as described in Chapter III, Section 3.A. The Infrastructure and Other Impacts criterion was plotted against final model prioritization results. A modest correlation ($R^2 = 0.33$) was found with overall model results, as shown in Figure 15.

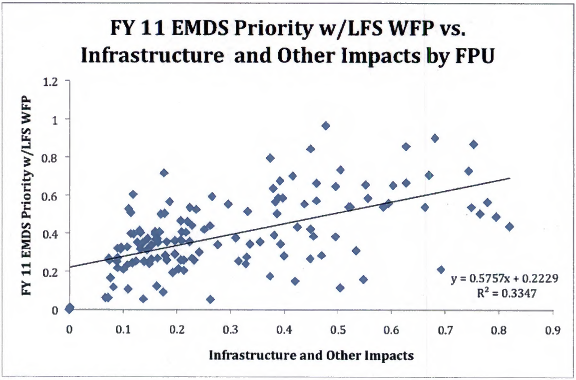


Figure 15. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and Infrastructure and Other Impacts Node

WUI Impacts Node. This node was one of two components of the Human Impacts sub-element within the Negative Consequences portion of the FY 11 model, as described in Chapter III, Section 3.A. The WUI Impacts criterion was plotted against final model prioritization results. A weak correlation ($R^2 = 0.20$) was found with overall model results, as shown in Figure 16.

Given the importance of WUI from a policy standpoint, this weak correlation led to further investigation of WUI contribution to the DOI EMDS model, described below in Chapter IV, Section 4.B.

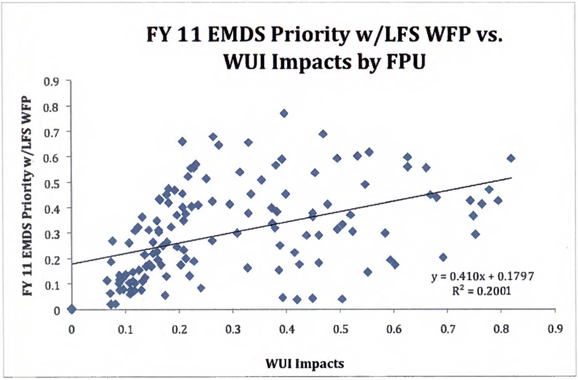


Figure 16. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and WUI Impacts Node

Negative Consequences Element—This second of the two top-level elements in the FY 11 model integrates the preceding four model nodes through their respective Human Impacts and Ecosystem Impacts sub-elements. The Negative Consequences element–level results were plotted against final model prioritization results. A moderate correlation ($R^2 = 0.68$) was found between the Negative Consequences element and overall model results, as shown in Figure 17.

Bearing in mind the variance displayed in the Negative Consequences component data distributions and the varying (and low) correlations at the nodal level, note the considerably weaker element-level correlation for Negative Consequences compared with the LFS WFP element–level correlation shown in Figure 12.

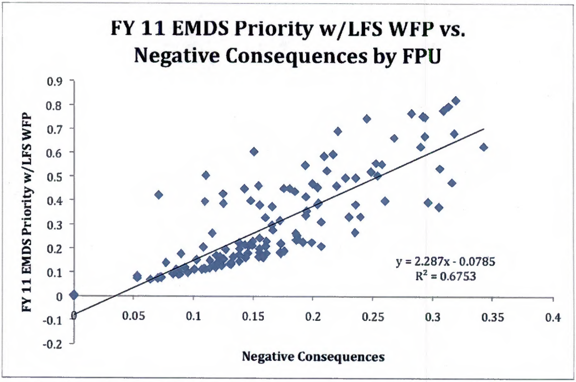


Figure 17. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and Negative Consequences Element

B. Additional Diagnostics

WUI Influence and Correlation Checks—The weak correlation observed between WUI Impacts and overall results (Figure 16) motivated additional exploration to understand better the influence of WUI in the model.

One hypothesis was that the weak correlation resulted from the low relative influence of the WUI Impacts node, which was limited to a weight of 0.19 owing to this node's placement within the hierarchical model structure. An experimental model run was made with the WFP element weight reduced to 0.1 and the Negative Consequences element weight raised to 0.9. Holding all other Negative Consequences components equal, this enabled the WUI Impacts node weight to be elevated to 0.61. A scatter plot of WUI Impacts and final results was then re-run, and is shown in Figure 18. The moderate correlation observed ($R^2 = 0.54$) suggests a future option to restructure the model, to place WUI Impacts at a higher level and permit application of a higher weight (if desired).

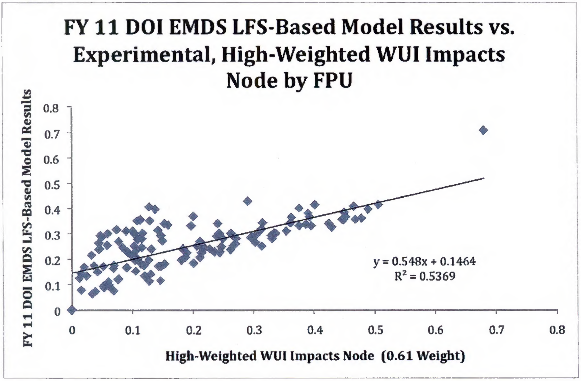


Figure 18. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and Experimental, High-Weighted WUI Impacts Node

Another hypothesis for the weak correlation was that a weak relationship exists between DOI lands and WUI (as modeled). To test this, a scatter plot was prepared to relate the WUI Impacts node to DOI lands by FPU. The result shown in Figure 19 ($R^2 = 0.0$) substantiates the fundamental absence of a relationship between this model node and DOI lands.

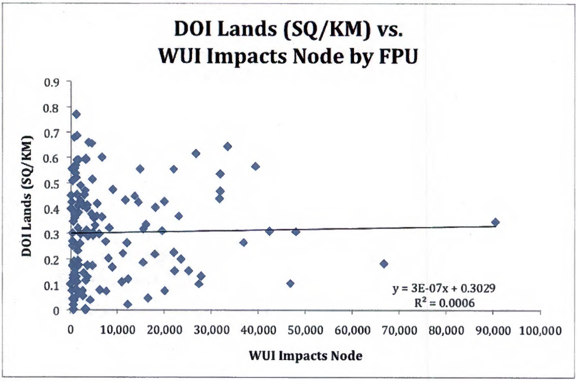


Figure 19. Scatter Plot of DOI Lands and WUI Impacts Node

As a second step, aggregate base WUI data (*without* the stratification of low, moderate, and high SFP) were plotted against DOI lands. The result shown in Figure 20 ($R^2 = 0.03$) substantiates not only the fundamental absence of a relationship between DOI lands and the representation of WUI in model input data, but also a slightly negative relationship between DOI lands and WUI occurrence.

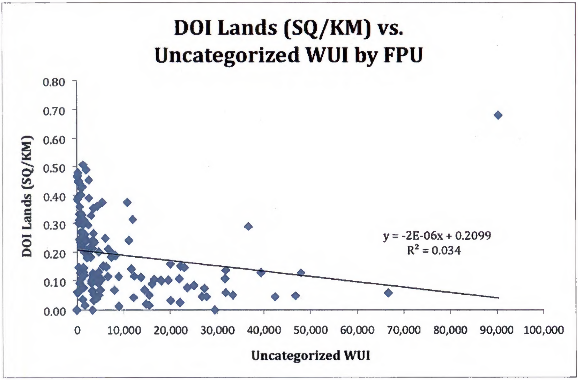


Figure 20. Scatter Plot of DOI Lands and Base Composite WUI Data

In interpreting these results with respect to actual WUI, one must clearly recognize model limitations. It should be emphasized, for example, that WUI in the model is a limited spatial composite representation of population and structures based on several national data sources (described in Chapter III, Section 3.A.). The model does not reflect Community Wildfire Protection Plans (CWPPs), owing to the absence of national spatially referenced CWPP data, nor does it reflect Community Assistance activities. Nor is the ephemeral presence of population (visitation) on DOI lands—often temporally coincident with the fire season—well-reflected in current model input data. This population presence would likely be mapped as WUI if it constituted resident population in a developed area. Rather, these relationships are strictly a result of (1) the available nationally consistent spatial composite input data used to represent WUI, and (2) WUI's spatial overlap with DOI lands. Nevertheless, these findings suggest that refinements and alternative methods of WUI representation might be considered.

Area-Related Model Bias Check—In addition to model component plots and investigation, and notwithstanding the joint and equal use of area and proportion in the model, the potential influence of relative DOI land area presence in FPU prioritization was further investigated. Optimally, a positive correlation should exist—but not a degree of correlation that would overwhelm the contribution of DOI's proportional presence in an FPU, or distinctions in biophysical characteristics between FPUs. The scatter plot comparing DOI area by FPU and overall model results shown in Figure 21 (R^2 = 0.46) shows such a positive but modest relationship.

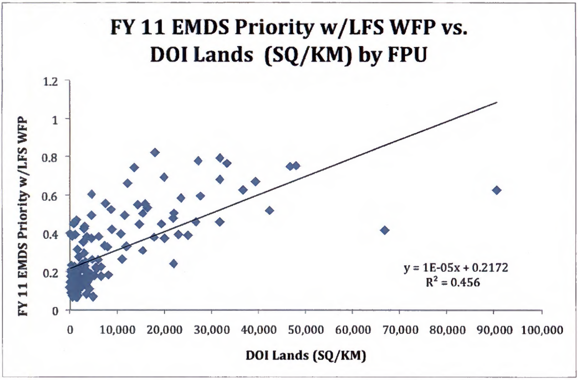


Figure 21. Scatter Plot of FY 11 DOI EMDS LFS-Based Model Results and DOI Area by FPU

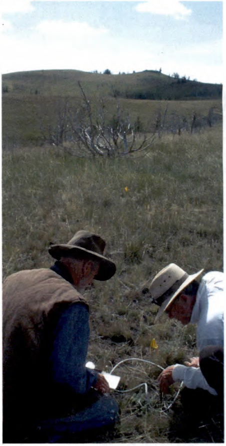
DOI FY 11 EMDS Analysis: Technical Issues and Recommendations

Chapter V

The material in this section is derived from comprehensive discussion and consensus in the FDSSC. The following discussion will occasionally reiterate or refer to content from the DOI FY 10 EMDS Report.[7]

A. Staffing, Schedule, and Tasking Scope

Assignment, tasking commitment, and administration of staff—Although EMDS is such a consequential activity, staffing continues to be handled ad hoc even after completion of five DOI EMDS reports. DOI Bureaus vary both in how they assign staff to EMDS duties (for example, as part of a detail versus as a collateral duty; as a temporary assignment versus an indefinite one), and in the amount of staff time available for EMDS versus other assigned duties. Discontinuity of assigned NPS staff both between and during recent analyses has also negatively affected efficiency and effectiveness. Reliance on overtime for some assigned EMDS staff but not for others also introduces risks and challenges to the project. When planning for EMDS evolution and other dimensions of FDSSC activity, the IFMC and Bureau line management should pursue uniformly structured staffing arrangements that account for FDSSC workload, to include staff recognition and development. The accomplishment and criticality of EMDS duties should be reflected in employee performance plans and appraisals.



Continuity of staffing, including leadership, and management—Staffing arrangements should reflect continuous and long-term requirements, especially for Lead and Analyst roles, in contrast with the short-term and temporary orientation of the current approach. Experience and continuity of team members significantly benefit FDSSC work efficiency in all areas. As noted in the DOI FY 10 EMDS Report: "Particularly as EMDS analyses mature to an operational status and/or embrace project management principles, consideration should be given to staffing a permanent Team Lead [now the FDSSC Chair] role. Continuity of other team staff would also be beneficial."[8]

---

[7] Johnson, R., G. Barnes, K. Gollnick-Waid, J. Wallace, M. Stuart, and S. Goodman, "Ecosystem Management Decision Support (EMDS): Summary of Fiscal Year 2010 Results," Prepared for the National Wildfire Coordinating Group Fuels Management Committee, U.S. Department of the Interior, Bureau of Land Management, Denver, CO, October 2009, 27. Available at *ftp://ftp.blm.gov/pub/gis/wildfire/EMDS_FY2010_Report* or upon request from the FDSSC or IFMC Chair.

[8] Ibid., 27.

FDSSC technical skill mix—With the addition of a second Analyst, as recommended in the FY 10 EMDS Report, the number and technical skill mix of FDSSC staff for the FY 11 EMDS analysis were nearly optimal. Continuity of this staffing approach is strongly recommended: one Project Manager (Chair), four Subject Matter Experts, and two spatial Analysts. However, as the analysis extends beyond CONUS, supplemental resources may be needed.

Temporary staff resources—Temporary assistance in geospatial processing and graphics was obtained for the FY 11 effort during brief periods when workload reached or exceeded available staffing limits. Retention and reinforcement of this temporary staffing option (along with more rigorous staffing plans) is recommended. Similarly, part-time administrative assistance with meeting minutes and related documentation should be considered.

Schedule issues and impacts—Compared with the schedule of previous analyses, the FY 11 EMDS schedule of approximately 3 months was an extraordinarily tight time frame, while the analysis was much more complex. The complexity, scale, and large volumes of data required for the analysis led to unexpected geospatial processing difficulties, for which scheduled time was not available. Consequently, successful completion of the FY 11 analysis significantly increased contention with other work commitments of FDSSC staff. A substantial investment of personal time was also required on the part of team members—a situation that subjects the project to unnecessary risk. Overall, the short schedule severely limited data discovery and preparation, technical investigation and improvements (including software options), comprehensive quality assurance (including field engagement), and technical process documentation. The fundamental problem with the DOI EMDS schedule remains the necessity to handle large data volume, develop new technical procedures, and meet aggressive milestones for both intermediate steps and final deliverables—*concurrently and within a compressed period of time.*

It is recommended that a firm schedule be developed within HFPAS for the EMDS prioritization analysis, and reflected in FDSSC tasking. Scheduling must better reflect the predetermined analysis scope and objectives and the complexity of the work, as well as other, competing FDSSC responsibilities and deliverables, and it must provide time for all supplementary tasks (for example, briefings, documentation, after action review, and so on. Based on current staffing allocation and workload commitment, and assuming a similar degree of change in model complexity as between the FY 10 and FY 11 analyses, future DOI EMDS analyses would require a minimum of 10 months for both technical and supporting, supplementary tasks to be completed. (Some improvements to the model could be accomplished in less time.) If substantial work or final deliverables are required during the summer months or Western fire season and FDSSC members are unavailable, the schedule may need to be more flexible. A dedicated staff committed to EMDS might reduce this estimate.

Schedule coordination and integration with other projects—The establishment of a firm project schedule, which was recommended in the DOI FY 10 EMDS Report, would allow better coordination with the NFPORS, FPA, LANDFIRE, the USFS EMDS effort, and other projects as regards essential base data updates, key milestones, and deliverables.

Geographic scope—As noted in the DOI FY 10 EMDS Report,[9] extension of EMDS analysis beyond CONUS is an important goal and recommendation. Tasking details and schedule must reflect the technical challenges that this extension would entail, including critical differences with CONUS base data and scale of geographic analysis units.

Tasking scope—The FDSSC has demonstrated the knowledge, skills, and (with schedule accommodation) capacity to provide greater and/or more formalized assistance in DOI fuels geospatial and decision support beyond the EMDS tasking. Such assistance could include further support of the overall HFPAS process through use of additional decision support tools. The full capacity of the FDSSC as a DOI HFPAS support resource should be defined and used.

B. EMDS Data and Model

Reassessment and action on the following base data and model issues are recommended for FY 12 and future DOI EMDS analyses:

1. ***Issue:*** There are technical questions about how to differentiate among low, moderate, and high ratings in the Ecosystem Vulnerability Matrix.

   Recommendation: Assign a task team and reassess the current matrix.

2. ***Issue:*** Inconsistencies exist between LANDFIRE EVT, FRG, and FRCC layers.

   Recommendation: Inform and engage LANDFIRE program; investigate alternative data layers.

3. ***Issue:*** Data for CONUS and non-CONUS lands are incomplete or inconsistently available (for example, lack of LANDFIRE FRCC data for Alaska).

   Recommendation: Investigate options, and develop proposal for model extension beyond CONUS.

[9] Ibid.

4. Several issues and recommendations pertain to representation of WUI in DOI EMDS models.

   a. ***Issue:*** Data quality limitations have required use of multiple, merged layers of data for a single WUI layer.

   Recommendation: Reevaluate the composite WUI (population and developed area layer) data approach, especially with regard to inclusion of NOAA Night Lights data, given its overlap and degree of redundancy with LandScan data components. Consider the benefits of consistency with the USFS EMDS WUI approach in defining the WUI base data set. Seek contemporary data based on 2010 U.S. Census information as an alternative to the aging FPA SILVIS layer. Obtain and use the most current LandScan data for WUI representation in the model.

   b. ***Issue:*** Stratification of WUI by SFP requires further investigation.

   Recommendation: Further investigate co-occurrence of WUI and fire potential.

   c. ***Issue:*** The current approach focuses on WUI on DOI lands, while the influence of proximity to neighboring (non-DOI) WUI is not reflected.

   Recommendation: Revalidate WUI data summarization from the standpoint of adjacency to WUI, and add precision to the definition of a "WUI treatment."

   d. ***Issue:*** There is no national geospatial data source that fully satisfies current WUI definitions and policy priorities.

   Recommendation: This fact must be recognized and accepted in both tasking and interpretation of EMDS analyses. National interagency direction, cooperation, and consistency of interpretation is essential and should be pursued by DOI, NWCG, and the Fire Executive Committee.

5. Several issues and recommendations pertain to LFS data.

   a. ***Issue:*** LFS metadata and technical documentation are lacking.

   Recommendation: Try to obtain better LFS metadata and technical references and to increase understanding of such issues as underlying LANDFIRE data provenance (for example, National, Rapid Refresh, Refresh, and Improvements),[10] parameters for and accuracy of crown fire simulation, and so on. Explore weather

[10] See ***http://www.landfire.gov/version_comparison.php***.

station calibration impacts and mitigation (pending LFS implementation of gridded weather).

b. ***Issue:*** LFS is subject to ongoing development and improvement.

Recommendation: Track and implement improvements in future models, including briefings to increase understanding of and confidence with LFS use. Implementation of gridded weather in LFS is critical for improved DOI EMDS modeling.

c. ***Issue:*** Simulation accuracy is potentially limited by the fact that LFS does not incorporate all ownerships (as is true of other WFP modeling as well).

Recommendation: Monitor and review incorporation of State fire data into LFS.

d. ***Issue:*** Significant differences exist between LFS WFP and legacy WFP in some areas.

Recommendation: Further explore and characterize differences between the LFS and the legacy WFP approach where significant divergence exists in FPUs or alternative analysis units.

6. ***Issue:*** Masking of Critical Infrastructure to non-WUI areas may not be appropriate.

   Recommendation: Reevaluate the best approach to Critical Infrastructure in the model.

7. ***Issue:*** Representation of CFP in the model is problematic.

   Recommendation: Validate and perform quality assurance (QA) of CFP in the model, considering weather scenario influence and the potential utility of LANDFIRE canopy base height, crown bulk density, ladder fuels, and so on.

8. ***Issue:*** Model does not currently incorporate organic soil contribution to WFP or Negative Consequences.

   Recommendation: If schedule allows or if future models address more extreme weather scenarios, explore utility and incorporation of organic soils via sources such as the Soil Survey Geographic and State Soil Geographic databases from the Natural Resources Conservation Service.

9. ***Issue:*** Given future use of legacy WFP as a crosscheck against LFS results, certain improvements may be in order for the legacy approach.

Recommendation: Schedule permitting, and with respect to the influence of ignitions on fire probability, investigate and assess the utility of available data for fires originating from lightning, human causes, and activities at recreation sites.

10. ***Issue:*** Critical Infrastructure source data used for this EMDS analysis have been updated.

    Recommendation: Obtain and use the most current HSIP Gold data set for representation of Critical Infrastructure in the model. Revalidate and explore additional data themes extracted from this source.

11. ***Issue:*** Smoke Impact approach does not reflect real impact or adequately differentiate between analysis units.

    Recommendation: Take a fresh approach to Smoke Impact suitable for current EMDS analysis scale, including exploration of use of the First Order Fire Effects Model data (and its 2.5 and 10 micrometer particulate matter components), non-attainment areas, Class I airsheds, and other suitable base data.

12. ***Issue:*** Use of LANDFIRE-based Non-Native Species layer may not provide nationally adequate coverage.

    Recommendation: Seek and evaluate alternative or supplemental national data sources for Non-Native Species to achieve more comprehensive and current coverage.

13. ***Issue:*** Adequate time for thorough exploration of alternative data sets has yet to be included in any DOI EMDS analysis.

    Recommendation: Explicitly plan and provide for the essential function of data discovery and QA to improve DOI EMDS analyses.

14. ***Issue:*** Model does not consider the mitigating effect of treatments on overall cost consequences of long-duration and high-cost fire types.

    Recommendation: Explore the potential for adapting model elements and adding components to account for long-duration and high-cost fires (similar, but not limited to, a stratified cost index).

15. ***Issue:*** The Performance and Opportunities model elements of prior DOI EMDS analyses were removed from the FY 11 "biophysical" model structure with the intention of

reincorporating them elsewhere in the restructured HFPAS process; however, this did not occur.

Recommendation: Reintroduce these important quantitative criteria for prioritization into the FY 12 DOI EMDS/HFPAS process.

16. ***Issue:*** The modeled parameters and DOI lands characteristics seem inherently to create results biased toward extreme fire behavior in grass versus timber fuel models.

    Recommendation: Provide time to complete further evaluation for all input and output steps. Assess the need for model modifications, such as including resistance to control, as does the USFS EMDS model.

17. ***Issue:*** The LFS model focuses on typical fire environment conditions and, so, leaves risks and hazards associated with more extreme wildland fire underrepresented in the analysis.

    Recommendation: This model orientation is not under FDSSC control; however, management consideration and direction are needed regarding tradeoffs between model orientations when using (a) SFP for WUI stratification, and (b) legacy WFP for comparison and crosscheck purposes against LFS.

18. ***Issue:*** The FY 11 two-element, hierarchical model structure constrains the influence of lower-level model components. Coequal weighting inhibits differentiation and works against the purpose of an EMDS analysis as a decision support tool.

    Recommendation: Reconsider the interplay between model component structure and hierarchical criteria weights (for example, WUI Impacts). Explore model structure revisions that would facilitate higher absolute and relative weights, such as raising WUI Impacts to an element or sub-element level.

19. ***Issue:*** The 2009 FPA FPUs may not be the optimal units for a stable EMDS analysis.

    Recommendation: Revisit the use of FPUs as observation units for DOI EMDS analysis, considering such factors as scale; consistency; stability; appropriate bio-eco-physical sampling and differentiation of units; and alignment with policy interests, administrative units, and funding allocation and management practices. Explore alternatives, with particular attention to consistency with USFS and/or "all lands" analyses. Formulate and propose alternatives based on technical merit.

C. Project Management

Assuming general continuity of the current approach to DOI EMDS analyses, the following issues and recommendations pertain.

Roles and responsibilities—At the current stage of maturity of DOI EMDS analyses, a fresh look at role definitions among the OWFC, the IFMC, the FDSSC, and SME representation of the field is warranted:

- There is an urgent need for an FDSSC charter and for a refinement of roles and responsibilities of the IFMC and the FDSSC. Matters requiring clarification include the FDSSC Chair's authority over team members' workload and priorities; the amount of initiative and powers of delegation available to the FDSSC; the potential to broaden FDSSC support of IFMC HFPAS needs; and the relationship of the FDSSC with other DOI and USFS decision support organizations and projects. The outcome should preserve and build on the FDSSC's demonstrated agility.
- Responsibility for communicating with senior management and the field should be clarified and should reflect the different roles of the IFMC, the FDSSC, and Bureau SMEs. Field engagement could relate to input, QA and validation, results briefings, and so on.
- Different levels of information flow from higher management to and among team members based on differences in FDSSC members' collateral roles and duties. Development of a charter should address the effects of this kind of communication on the FDSSC's performance and on its effectiveness as a decision support resource.

EMDS project design and improvement—Based on lessons and experience from several years of developmental DOI EMDS analyses, in general, and the FY 11 analysis in particular:

- A process and suitable schedule for validating DOI EMDS results remain lacking. Validation is critical for a stable DOI EMDS baseline. It should focus on biophysical and other objective measurements, based on independent interagency and/or DOI enterprise data and sources. Comparing where funds have previously been expended may be an effective accountability metric but is not adequate as a model validation metric.
- Integration of fuels treatment effectiveness measures would be a critical evolutionary step in EMDS modeling.
- Consideration should be given to restoring the Performance and Opportunities model elements unless they are integrated elsewhere in the HFPAS process as intended.
- The Negative Consequences model element should include additional components, such as water supply, recreation use areas, cultural resources, threatened and endangered species, commercial use areas, burned area severity effects, and organic soils.
- Coordination between DOI and USFS EMDS analyses (objectives, schedule,

analysis units, model structure, source data, communications, results, and so on) should be strengthened and reflected in future project design and tasking—consistent with emerging wildland fire policy direction concerning joint analysis and collaboration on all ownerships.

- Considering trends in hazard and risk analyses, and compatibility with these ongoing efforts, the FDSSC should investigate the relative merits of EMDS-based and GIS-based assessments and the tradeoffs between these approaches.

Processes, practices, and communications—DOI EMDS analyses have reached a point of maturity and a degree of complexity that warrant improved business practices:

- *The most critical and immediate need in DOI EMDS is to develop process documentation.* Thus far, process documentation has been limited to such descriptions as the metadata appendixes to the EMDS reports. Time pressures arising from aggressive schedules, growing task complexity, and limited, part-time staff have required that EMDS efforts focus almost entirely on simply organizing, executing, and delivering successive DOI analyses. Yet the ability to demonstrate a fully transparent, systematic, repeatable process (together with achieving a stable DOI EMDS baseline) is just as critical as are the analysis results themselves. *The FDSSC strongly advises that efforts during the 3–6 months following the FY 11 EMDS analysis should focus on developing process documentation rather than on an immediate re-tasking of an FY 12 EMDS analysis that might be little different from its predecessor.*
- Future EMDS tasking, schedules, and execution will benefit from firm dates at which key decisions regarding model inputs, structure, and weights would be "locked down." Adherence to final schedule milestones would facilitate work management and better enable team members to meet tasking requirements.
- Senior management should carefully consider the timing of the EMDS project within the fiscal year to facilitate better coordination with other relevant programs and projects.
- Communications between the IFMC and the FDSSC should be improved. Ongoing communication through the FDSSC Chair and through joint IFMC- FDSSC meetings should be supplemented by a monthly joint meeting or teleconference.
- Decisions concerning FDSSC-related business should be documented more formally, both within the FDSSC and at the IFMC level. It is important that meeting notes, conference call notes, and documentation of major decisions be maintained and be accessible to the FDSSC and the IFMC.
- Greater attention to hazardous fuels treatment objectives, definitions, protection goals, and scientific hypotheses could yield better long-term results than an approach that focuses only on continuity of past model structure and successive analyses. Separating

EMDS development from delivery of regular analyses would facilitate both model stability and improvement (addressed further in Chapter VI).

- Opportunities should be created for SMEs and analysts to receive greater technical familiarization and orientation on data processing and modeling, especially when personnel turnover occurs. The process documentation recommended above would facilitate this.
- Field engagement (for example, information briefings) should be interagency in nature or, at least, consistent among Bureaus, to promote common understanding and help manage expectations. The IFMC should give priority consideration to the utility, timing, and objectives of EMDS field engagement and should build consensus and provide direction in this regard.

Infrastructure and logistics—The following points address needed improvements in FDSSC/EMDS efficiency and evolution toward a stronger project management foundation:

- A more efficient means to share data, briefing materials, and documents is urgently needed, given the geographical dispersion of team members and infrequent opportunities to meet face-to-face. Because of increasing IT security constraints and burgeoning data volumes, FDSSC requirements now often exceed the capability of available FTP (File Transfer Protocol) resources and e-mail attachments. A dedicated, Internet-based solution is critical, and IFMC and/or OWFC consideration of funding for this purpose is recommended and requested.
- Similarly, the project should be allocated budget for such needs as geospatial, statistical analysis, and project management software or license access; modest hardware, storage, and server space; and so on. Acquisition of computers with custom IT configurations more conducive to complex GIS processing, or modification of existing computers toward this end, should be explored.
- The DOI FY 11 EMDS effort made very productive use of Web-based meeting and collaboration tools. Use of such tools should continue.

Chapter VI

The Future of DOI EMDS Analysis: Closing Thoughts on Stability and Strategic Considerations from the FDSSC Chair

A fundamental question of interest to senior management is when and to what degree DOI EMDS may be "stabilized." The past three DOI EMDS analyses have entailed closely consecutive, increasingly aggressive schedules with fundamentally different and progressively more complex requirements. Combined with the largely ad hoc approach to staffing (reliance on part-time and variable staff support), this situation has increased the difficulty of meeting objectives and has posed risk to project quality and timeliness. *Just as critical, it has directly impeded the establishment of a stable DOI EMDS baseline desired by senior management.*

Decision support pioneer Dr. George E. P. Box noted that "all models are wrong, but some are useful." The question that underpins the stability issue is, "When is the model useful *enough*?" There is often a temptation to focus on the significance of a model's limitations rather than on its utility, or perhaps on the technical details and options that pertain to model limitations of particular interest. Frequently, this leads to new tasking or pressure on a technical team to produce alternative solutions and recommendations for incremental improvements in subsequent analyses. However, as Dr. Box indicates, all models ultimately have irreducible limitations in representing and evaluating complex information. Consequently, the question "When is a model useful *enough*?" is inevitably not just a technical question *from* management, but also a programmatic question (and decision) *for* management.

DOI EMDS capabilities and results have reached a timely point to revisit programmatic considerations, which may be as relevant to the question of EMDS stabilization as any technical dimensions covered at length elsewhere in this report. From a programmatic standpoint, three essential strategic considerations pertain: responsiveness to program requirements and objectives; the interrelatedness of EMDS and other DOI wildland fire enterprise programs; and the benefits of an Operations and Maintenance (O&M) lifecycle approach to DOI EMDS.

1. EMDS Responsiveness to Current and Anticipated Program Requirements and Analysis Objectives

EMDS analysis units, model structure, and data inputs must reflect current hazardous fuels reduction program requirements, policy, and objectives (to the maximum extent supportable by technical capabilities and given the quality and national consistency of base data). From this point of departure, key questions might include: Has sufficient validation been accomplished for QA of current results? What are the technical and scheduling tradeoffs between stabilizing the model and developing it further in order to meet the anticipated requirements of future analyses? If an analysis falls short of objectives, and/or the approach must clearly be modified to meet evolving requirements, then further development must be accepted at the expense of short-term stability. Conversely, schedule considerations may argue against further development, since the greater the need for (or complexity of) technical development, the more time will be required to accomplish it. In addition, other external schedules (for example, base data updates) and the need to meet HFPAS decision support deadlines may in themselves constrain EMDS development options.

Note: The divergence from past approaches was greater in the FY 11 DOI EMDS analysis than in any previous case. The process entailed almost entirely new, previously untried methods, with results delivered on an aggressive schedule that severely limited the time for validation. Consequently, the FY 11 results may not constitute a prudent baseline for immediate stabilization.

2. EMDS Functions, Effectiveness, and Links within DOI Enterprise Programs and Architecture

Currently, EMDS serves as one component in the fuels budget allocation decision process (that is, HFPAS). As a model, it has relied on dynamic and evolving data from such other programs as NFPORS, LANDFIRE, and FPA. Considering EMDS stabilization in this context, strategic questions might include:

- To what extent is EMDS affected by program cycles? Should EMDS objectives and schedule be coordinated with them? Conversely, how does—or should—EMDS affect or contribute to other programs?
- What program relationships are complementary or mutually reinforcing? Are any functions overlapping or redundant?
- What is the cost-effectiveness of current activities, and might more efficient alternatives exist for coordinating program functions?
- How does EMDS fit within evolving DOI decision support organizations and functions?
- What roles and opportunities exist for DOI EMDS as a component to advance interagency decision support coordination with USFS—and within an "all lands" framework such as the emergent Cohesive Strategy mandated by the FLAME (Federal Land Assistance,

Management, and Enhancement) Act of 2009?[11]

Such considerations may be as relevant to the decision of when to stabilize EMDS as the technical state of the model. As noted in the DOI FY 10 EMDS report:

> From a programmatic standpoint, it is suggested that OWFC and FMC consider and articulate the relationships, synergies, interfaces, and integration envisioned between EMDS and other DOI programs such as Fire Program Analysis (FPA), Wildland Fire Decision Support System (WFDSS), LANDFIRE, and NFPORS.[12]

The successful DOI FY 11 EMDS effort presents a very timely opportunity for the OWFC, the DOI Fire Directors, and the IFMC to assess the state and adequacy of DOI EMDS, both on its own and in conjunction with all major DOI activities and programs that pertain to hazardous fuels allocation decision support. A fresh look may reveal opportunities to define a stable, annual HFPAS calendar and to articulate a longer-term direction for the roles and expected contributions of each major activity. Clarification of the adequacy or expected evolution of DOI EMDS in this context would facilitate a stable, focused EMDS capability to be strategically positioned within the suite of DOI enterprise programs.

3. Benefits of an Operations and Maintenance (O&M) Lifecycle Management Approach to DOI EMDS (Obtaining ***Both*** Stability ***and*** Improvement)

A fundamental dilemma, and a source of escalating risk to EMDS efforts, has been the requirement to invent new, long-term solutions while increasingly struggling to meet immediate HFPAS deadlines. Placing DOI EMDS efforts on an O&M footing would not only mitigate project risk but also circumvent the seemingly irreconcilable choice between stability and improvement—capturing the benefits of both. The critical outcome would be separation of essential experimentation and development activities from operational analysis work and deliverables. This approach would also inherently relieve staff workload and lessen project schedule contention while supporting EMDS quality assurance. As noted in the DOI FY 10 EMDS Report:

> While recent analyses have required both development and actionable results to be achieved concurrently…, the ultimate EMDS O&M concept might entail integration of relatively stable models and/or results into a 3–5 year planning and improvement cycle. In such a concept … technical improvements would be accumulated and tested between rather than during successive analyses, and would be implemented in periodic lifecycle updates of the models. Year-to-year volatility would be

[11] For more information about the Cohesive Wildfire Management Strategy, see Title V of Public Law 111-88, especially Section 503.

[12] Ibid., 29.

removed while facilitating longer-term strategic planning.[13]

This lifecycle approach would facilitate the structured development of DOI EMDS in concert with evolution of base data, technology, and policy priorities. A longer-term EMDS cycle might also extend the utility of EMDS in budget formulation as well as near-term budget allocation, leveraging EMDS capabilities to employ multiple biophysical and management decision elements at different scales. Note that this concept would not relieve the need for more formal staffing. Adoption of the lifecycle approach would require commitment of full-time staff but would also permit better definition and management of skill mix, levels of effort, and schedules consistent with O&M principles.

Because the stability of EMDS can and should be strategically managed, preoccupation with EMDS and its technical "instability" is undue and arguably misplaced. The FY 11 EMDS approach was necessarily revised to serve (as always) as one component of HFPAS overall. There is without doubt much more work to be done. But the critical advancement that has been made in helping to identify the highest-priority areas toward which to target the highest-priority treatments—on an all-DOI-lands basis—represents substantially more progress than could have been attained with prior approaches.

Therefore, in the broader view, the three strategic considerations discussed above might also be applied to the overall DOI HFPAS process. This is especially true given the revisions and complexity introduced for the FY 11 HFPAS, including components such as the Treatment Prioritization System and Management Considerations. As noted in the DOI FY 10 EMDS Report:

> Extending the development-to-operations lifecycle concept to HFPAS, DOI leadership could adaptively manage increasing use of decision support technology (including but not necessarily limited to geospatial EMDS) in the allocation process, balancing the evolving capability of the technology with its limitations. Such an approach could be responsive to continuing direction for improved hazardous fuels allocation processes, without an inferred obligation (for example) to [permanently] force-fit a greater proportion of the allocation problem than can or should be borne by EMDS geospatial analysis [or another HFPAS component] alone.[14]

[13] Ibid., 32.

[14] Ibid., 34.

Biographies, DOI FY 11 FDSSC Members

Gerald Barnes has been a BIA National Management Analyst for the last 4 years (supporting EMDS and FPA) and is a member of the DOI National Southern Burned Area Emergency Response (BAER) team. A former Passamaquoddy Tribe Forest Supervisor (Maine), he has 19 years in wildfire crew and incident management team experience and has served as GIS Coordinator for the Penobscot and Passamaquoddy Tribes and the Cerro Grande Fire BAER implementation. He also has 18 years of experience in forest management. Mr. Barnes holds a B.S. degree in Forestry from the University of Maine, Orono.

Andy Bundshuh has been the Regional Fuels Specialist for the NPS Intermountain Region for the past 2 years, working out of the Denver regional office. Previously, he worked in wildland fire and fuels management programs for 20 years: 3 years as the Fire Management Officer at El Malpais National Monument in Grants, New Mexico; 2 years as the Assistant Fire Management Officer at Indiana Dunes National Lakeshore in Chesterton, Indiana; 2 years as a Wildland Fire Operations Specialist at Big Bend National Park in Texas; 3 years as the Zortman Fire Station Manager for the BLM in Montana; 6 years as a Fire Operations Specialist at New River Gorge National River in Glen Jean, West Virginia; 2 years on the NPS Alpine Hotshot Crew; and 2 years at Mesa Verde National Park near Cortez, Colorado. Mr. Bundshuh holds a B.S. degree in Recreation and Park Administration from Central Michigan University in Mt. Pleasant, Michigan, as well as a Technical Fire Management Certificate from Washington Institute in Bothell, Washington.

Krista Gollnick-Waid has been a BLM Fire and Fuels Management Program Lead for the past 12 years, working at the National Interagency Fire Center (NIFC) for the past 2 years after 10 years at the Idaho State Office in Boise. In addition to providing policy and program support to efforts such as FPA, WFDSS, and DOI EMDS-HFPAS, she has represented the BLM as a technical expert on several national and regional interagency fire hazard and risk assessments. Since 1999 she has worked as a Long-Term Analyst supporting national Wildland Fire Incident Management Teams, conducting fire behavior analyses. Before working for the BLM, Ms. Gollnick-Waid was a Fuels Specialist on the Wenatchee and Winema National Forests, starting her career on an Initial Attack Fire Crew in 1984. She holds a master's degree from the College of Forestry at Duke University in Environmental Management and a master's degree from

the University of Washington in Fire Ecology. She also holds a B.S. degree in Biology, with a minor in Economics, from Whitman College in Walla Walla, Washington.

Susan Goodman has been the Fire Management Specialist at the BLM's National Operations Center for the past 18 years. As the Bureau's National Wildland Fire Geospatial Coordinator, she serves as a technical advisor to the WFDSS data group and chairs the BLM State Fire GIS Council. She has also served as the Lead Analyst for the DOI EMDS-HFPAS team for the past 3 years. Before working for the BLM, Ms. Goodman was a Fuels Forester on the Plumas National Forest. She holds an M.S. degree in Natural Resources from Humboldt State University; a B.S. degree in Forestry from the University of California, Berkeley; and a Technical Fire Management Certificate from Washington Institute.

Russell Johnson has been on detail assignment to the DOI OWFC for the past year as Team Lead and Chair of the FDSSC. He previously served in diverse project and line management roles at the U.S. Geological Survey (USGS) Center for Earth Resources Observation and Science (EROS) for 11 years, including satellite remote sensing projects (such as system development, test, and operations readiness for Landsat 7 and other satellite systems); customer service, applications, and data/information support; and fire science. He led USGS EROS LANDFIRE activities for the final 2 years through charter completion, while also serving as Deputy Chief and Acting Chief of the Fire Science Branch. Mr. Johnson also has more than 7 years' experience as a Research Scientist at the Environmental Research Institute of Michigan, specializing in and leading remote sensing and geospatial research, resource monitoring applications, and technology transfer activities. A veteran U.S. Navy line officer, he holds an M.S. degree in Natural Resources and a master's degree in Public Policy from the University of Michigan and a dual B.A. degree in Geology and Natural Resource Studies, along with a Certificate in International Relations, from the University of Rochester (New York).

Jerry Szymaniak has been with the EMDS project since February 2010. He has served as a regional wildland Fire Planner with the USFWS for the past 4 years, where he prioritizes resources and workloads for the USFWS fire and fuels programs within the 7 states of the Midwest region. Before his current position he was an interagency fire planner for the Federal fire agencies within the State of Minnesota, hosted by the USFS. For 3 years in that position he supported two Fire Planning Units for the FPA effort. He worked as a Computer Specialist supporting users of the BLM at the NIFC in Boise, Idaho. At NIFC he also worked for the BLM as a Lead Dispatcher at the National Interagency Coordination Center (NICC) where, in addition to dispatching duties, he co-authored computer programs for various dispatch database functions and national situational map displays. He has served in various fire and dispatch positions on five national forests and as a Park Ranger with the

Michigan Department of Natural Resources. He holds a B.S. degree in Forestry with honors from Michigan Technological University.

Jon Wallace is the Prescribed Fire Specialist for the Arthur R. Marshall Loxahatchee National Wildlife Refuge complex in South Florida. He has been with the USFWS for 4 years, following 13 years with the Mississippi Forestry Commission as a Forester and Fire Management Specialist. Mr. Wallace has been a federally qualified Firefighter for 24 years and is currently a member of a Type 1 Incident Management Team as a Division Supervisor and Fire Behavior Analyst, and is also a Type 1 Burn Boss. Mr. Wallace is chair of the Southern Region's predictive services group and the DOI Southern Regional WFDSS Coordinator. He holds a B.S. degree in Forest Management from Auburn University.

Appendixes

Appendix 1

DOI FY 11 EMDS Metadata Summary Table

Appendix 2

DOI FY 11 Ecosystem Vulnerability Matrix

Appendix 3

DOI FY 11 EMDS Legacy WFP Model Alternative Results

Appendix 4

DOI FY 11 EMDS Model Raw FPU Results

Appendix 5

DOI FY 11 EMDS Sensitivity Tables and Discussion

Appendix 1

DOI FY 11 EMDS Metadata Summary Table

Element	Sub-Element	Component	Description	Source	Processing Step	Summary Unit
Wildfire Potential	Fire Probability	Large Fire Simulator	Classifies a landscape's probability of wildfire by vegetation (fuel), weather, topography, and proximal fire influences. A landscape's WFP was separated into categories based on the probability of a wildfire occurring with a given flame length. Categories were defined by 2-ft flame length intervals.	Produced by the MFSL, this layer used LANDFIRE National 40 Scott and Burgan (2005) Fire Behavior Fuel Models (FBFM 40) raster data, along with a Fire Simulation system and a synthetic weather generator. Fire Intensity Level was derived from the vector of marginal burn probabilities and was a categorical value based on expected flame length. The fire intensity levels were associated with 0–2 ft, 2–4 ft, 4–6 ft, 6–8 ft, 8–10 ft, 10–12 ft, and > than 12 ft flame length categories. This data layer was produced for the FPA effort. [15]	Probabilities were reclassified according to the Hauling chart standard flame lengths. Used standard ESRI Join and Selection. Used the Tabulate Area under Zonal tab of Spatial Analyst Tools along with the Land Status layer to calculate area. In the logic model flame lengths' burn probability 0–4 ft, 4–8 ft, and > 8 ft, were multiplied by 1, 2, and 4, respectively.	Summarized by area (SQ/KM) and proportion.
Wildfire Potential	Fire Behavior (Legacy)	Crown Fire Potential	Differentiates the CFP of vegetation types based on surface fire intensity. CFP was limited to forested areas.	LANDFIRE National EVT raster layer was categorized as tree-dominated, coniferous overstory, with 60 percent or greater crown closure; coincident with moderate and high surface fire as calculated in the SFP component. DOI Land Status layer developed for the FDSSC by BLM NOC.	Used standard ESRI Join and Selection to reveal areas with the given CFP. Values were either YES or NO. Used the Tabulate Area under Zonal tab of Spatial Analyst Tools along with the Land Status layer to calculate area	Summarized by area (SQ/KM) and proportion.
Wildfire Potential	Fire Behavior (Legacy)	Surface Fire Potential	Differentiates the SFP off the Hauling charts using BEHAVE Plus	Recalibrated LANDFIRE National 40 Scott and Burgan (2005) Fire Behavior Fuel Models (FBFM 40) raster layer was source data for the SFP component. DOI Land Status layer developed for the FDSSC by BLM NOC.	BEHAVE Plus was used to calculate moderate and high SFP. Each of the 40 fuel models was given a rating of 0 for low, 1 for moderate, and 2 for high. Value breakpoints were based on the Hauling chart flame length categories. Used the Tabulate Area under Zonal tab of Spatial Analyst Tools along with the Land Status layer to calculate area.	Summarized by area (SQ/KM) and proportion.

[15] Finney, "A Prototype Simulation System for Large Fire Planning in FPA."

CFP = Crown Fire Potential; EVT = Existing Vegetation Type; FPA = Fire Program Analysis; LFS = Large Fire Simulator; MFSL = Missoula Fire Sciences Laboratory; NOC = National Operations Center; SFP = Surface Fire Potential; WFP = Wildfire Potential

DOI FY 11 EMDS Metadata Summary Table (continued)

Element	Sub-Element	Component	Description	Source	Processing Step	Summary Unit
Wildfire Potential	Fire Probability (Legacy)	Solar Radiation	Monthly and annual average solar resource potential for CONUS	NREL and universities for the U.S. Department of Energy DOI Land Status layer developed for the FDSSC by BLM NOC.	Solar Potential values of excellent, very good, and good were included, and low and moderate values were excluded from analysis. Used the Identity Tool under the Overlay tab of the Analysis Tool to add Solar Radiation column to the Land Status layer. Used the Summarize Table Tool to calculate area by FPU.	Summarized by area (SQ/KM) and proportion.
Wildfire Potential	Fire Probability (Legacy)	Fire Starts	Number of wildland fires from the DOI 1202 fire occurrence databases	Data was compiled for 2000–2009 from WFMI for BIA, BLM, and NPS. The above data was merged with USFWS data from the FMIS into a spatial geodatabase.	Summarized the number of fires for fire types 11–23 and 49 by FPU.	Summarized by number of fires.
Wildfire Potential	Fire Probability (Legacy)	Large Fires	Number of wildland Large Fires from the DOI 1202 fire occurrence databases	The Fire Starts geodatabase was used.	Large Fires are defined by life form and are consistent with NICC reporting for Large Fires: Timber Fires >= 100 acres are considered Large Fire; all other fires >= 300 acres are considered Large Fire. For consistency purposes, the same forest mask was used as mentioned under CFP.	Summarized by number of Large Fires.

CONUS = Continental United States; FMIS = Fire Management Information System; FPU = Fire Planning Unit; NICC = National Interagency Coordination Center; NREL = National Renewable Energy Laboratory; WFMI = Wildland Fire Management Information System

DOI FY 11 EMDS Metadata Summary Table (continued)

Element	Sub-Element	Component	Description	Source	Processing Step	Summary Unit
Negative Consequences	Human Impacts	Wildland Urban Interface Impacts	Categorized WUI with SFP that overlaps DOI Bureau lands.	FPA SILVIS Lab, University of Wisconsin, and NE Research Station Wildland Urban Interface in vector format. NOAA 2008 Nighttime Lights image and data processed by NOAA's National Geophysical Data Center. The data source was the Defense Meteorological Satellites Program data collected by the U.S. Air Force Weather Agency. Data layer used was 2008 Night Lights in raster format. NGA HSIP Gold data set (2006) LandScan product. LandScan Global was developed by Oak Ridge National Laboratory with funding by the U.S. Department of Defense. Data used was 2006 CONUS LandScan–Night in raster format. NPS Structure layer in vector format was developed for WFDSS. Recalibrated LANDFIRE National 40 Scott and Burgan (2005) Fire Behavior Fuel Models (FBFM 40) raster layer was source data for the SFP component. DOI Land Status layer in vector format developed for the FDSSC by BLM NOC.	Converted FPA Silvis WUI layer to raster format to simplify the layer. Converted the raster FPA Silvis WUI layer back to vector format. Reclassified 2008 Night Lights with values of 0–3 as non-WUI. All other values were labeled as WUI. Converted 2008 Night Lights raster layer to vector format. Note: Datum shift issues exist with this layer. Converted 2006 CONUS LandScan–Night raster layer to vector. Buffered this layer by 1 km to improve currency of layer. Layer was then converted back to raster format to simplify the layer. The buffered, simplified layer was then converted back to vector. NPS Structure layer was buffered by 1 km. Buffered NPS Structure layer was converted to raster to simplify the layer. The buffered, simplified layer was then converted to vector. Used the Union Tool under the Overlay tab of the Analysis Tool to combine all four layers. Combined WUI Layer was then converted to raster. Used the Combined Tool under Local tab in Spatial Analyst Tools to add SFP rating column to categorized WUI. Used Zonal Statistics as Table under Zonal Tab of Spatial Analyst Tools to calculate area by FPU with the DOI Land Status layer.	Summarized by area (SQ/KM) and proportion.

NOAA = National Oceanic and Atmospheric Administration; WFDSS = Wildland Fire Decision Support System

DOI FY 11 EMDS Metadata Summary Table (continued)						
Element	**Sub-Element**	**Component**	**Description**	**Source**	**Processing Step**	**Summary Unit**
Negative Consequences	Human Impacts	Infrastructure and Other Impacts (Smoke Impact)	Smoke Impact layer focuses on areas where people are most likely to be negatively affected.	FY 2011 EMDS WUI Impact layer DOI Land Status layer developed for the FDSSC by BLM NOC.	Buffered WUI Impact layer by 5 miles to create Smoke Impact layer. Clipped Smoke Impact layer to DOI Land Status. Calculated area by FPU.	Summarized by area (SQ/KM) and proportion.
Negative Consequences	Human Impacts	Infrastructure and Other Impacts (Critical Infrastructure)	Buffered layer of interstate, Federal, and State highways, railroads, communications and navigation antenna sites, and selected energy infrastructure locations.	NGA HSIP Gold data set (2006) DOI Land Status layer developed for the FDSSC by BLM NOC.	A subset of the HSIP Gold critical infrastructure data was extracted after rigorous investigation of the attribute tables. The selected data sets were then combined. A 100-ft buffer was then applied to create the data subset. A dissolve operation was utilized to eliminate co-occurrence. Then the WUI areas were erased to derive the intended Critical Infrastructure area outside WUI for use in the analysis. Clipped Critical Infrastructure layer to DOI Land Status layer. Calculated area by FPU.	Summarized by area (SQ/KM) and proportion.

DOI FY 11 EMDS Metadata Summary Table (continued)						
Element	**Sub-Element**	**Component**	**Description**	**Source**	**Processing Step**	**Summary Unit**
Negative Consequences	Ecosystem Impacts	Ecosystem Vulnerability	Ecosystem Vulnerability depicts the exposure of the ecosystem to stress.	LANDFIRE National FRCC raster layer LANDFIRE National FRG raster layer LANDFIRE National EVT raster layer DOI Land Status layer developed for the FDSSC by BLM NOC.	Used the Combined Tool under Local tab in Spatial Analyst Tools to create a matrix layer for FRCC with FRG and EVT. Added a field for Ecosystem Vulnerability Rating. Populated the field by using the Ecosystem Vulnerability Matrix in Appendix 2. Used Zonal Statistics as Table under Zonal tab of Spatial Analyst Tools to calculate area by FPU with the DOI Land Status layer.	Summarized by area (SQ/KM) and proportion.

DOI FY 11 EMDS Metadata Summary Table (continued)

Element	Sub-Element	Component	Description	Source	Processing Step	Summary Unit
Negative Consequences	Ecosystem Impacts	Non-Native Species	A vegetative species found outside of its natural range.	LANDFIRE National EVT raster layer 2180 Introduced Riparian Vegetation, 2181 Introduced Upland Vegetation–Annual Grassland, 2182 Introduced Upland Vegetation–Perennial Grassland and Forbland, 2183 Introduced Upland Vegetation–Annual and Biennial Forbland, 2185 Introduced Wetland Vegetation–Mixed, 2186 Introduced Upland Vegetation–Shrub, 2187 Introduced Upland Vegetation–Tree, 2536 Introduced Wetland Vegetation–Tree, 2537 Introduced Wetland Vegetation–Shrub, 2538 Introduced Wetland Vegetation–Herbaceous. LANDFIRE National S-Class raster layer S-Class E 6 UN Uncharacteristic Native Vegetation Cover/ Structure /Composition S-Class E 7 UE Uncharacteristic Exotic Vegetation DOI Land Status layer developed for the FDSSC by BLM NOC.	Used Extract by Attribute under the Extraction tab of Spatial Analyst Tools to create a subset from S-Class that included only S-Classes 6 and 7. Used Extract by Attribute under the Extraction tab of Spatial Analyst Tools to create a subset from EVT that included only values 2180, 2181, 2182, 2183, 2185, 2186, 2187, 2536, 2537, and 2538. Combined the S-Class and EVT subsets to create the Non-Native layer. Used Zonal Statistics as Table under Zonal tab of Spatial Analyst Tools to calculate area by FPU with the DOI Land Status layer.	Summarized by area (SQ/ KM) and proportion.

Appendix 2

DOI FY 11 Ecosystem Vulnerability Matrix

Life Form	FRG	FRCC	Ecosystem Vulnerability Rating
Forest	1	3	High Impact
	2	2	High Impact
	2	3	High Impact
	3	3	High Impact
	4	2	High Impact
	4	3	High Impact
	1	2	Moderate Impact
	2	1	High Impact
	3	2	High Impact
	4	1	Moderate Impact
	5	3	Moderate Impact
	1	1	Low Impact
	3	1	Low Impact
	5	1	Low Impact
	5	2	Low Impact
Shrub	1	3	High Impact
	2	2	High Impact
	2	3	High Impact
	3	2	High Impact
	4	2	High Impact
	1	2	Moderate Impact
	2	1	Moderate Impact
	3	3	Moderate Impact
	4	3	Moderate Impact
	5	3	Moderate Impact
	1	1	Low Impact
	3	1	Low Impact
	4	1	Low Impact
	5	1	Low Impact
	5	2	Low Impact
Grass	1	3	Moderate Impact
	2	2	High Impact
	2	3	High Impact
	3	3	Moderate Impact
	4	2	Moderate Impact
	4	3	Moderate Impact
	1	2	Moderate Impact
	2	1	Moderate Impact
	3	2	Moderate Impact
	4	1	Low Impact
	5	3	Moderate Impact
	1	1	Low Impact
	3	1	Low Impact
	5	1	Low Impact
	5	2	Moderate Impact

Fire Regime Group (FRG) Key		
	Return Interval (yrs)	Severity
1	0–35	low–mixed
2	0–35	high (stand replacement)
3	35–200	low–mixed
4	35–200	high (stand replacement)
5	200+	Any

Appendix 3

DOI FY 11 EMDS Legacy WFP Model Alternative Results

The comparison between the LFS-based and DOI legacy approaches for WFP and the decision to employ the LFS-based model for "final" FY 11 DOI EMDS results were described in Chapter IV. In the interest of completeness, this appendix will provide the alternative overall results of the legacy WFP-based model, including scatter plot sensitivity analysis (EMDS sensitivity tables for the legacy-based results are provided in Appendix 5, Section C). For brevity's sake, given that analogous descriptions and interpretations apply, this appendix will focus on graphics with minimum explanatory text. Appendix 4 provides uncategorized, raw model results for the FPUs.

The legacy WFP and Negative Consequences element–level map graphic results may be found in Chapter IV, Figures 5 and 8, respectively. Note that the Negative Consequences element was unchanged in the legacy WFP-based model, and all results and sensitivity analysis within that element may be also be found in Chapter IV.

A. Overall Results with DOI Legacy WFP Method

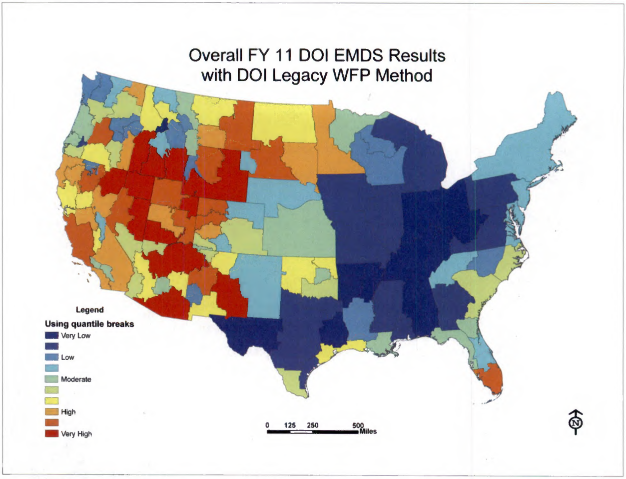


Figure A3-1. Overall FY 11 DOI EMDS Results with DOI Legacy WFP Method (quantile breaks). Compares with Chapter IV, Figure 9 (LFS-based results).

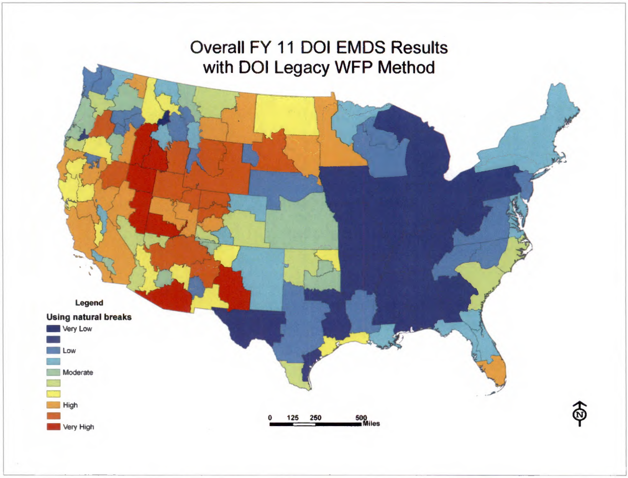


Figure A3-2. Overall FY 11 DOI EMDS Results with DOI Legacy WFP Method (natural breaks). Compares with Chapter IV, Figure 11 (LFS-based results).

B. Legacy WFP Model Sensitivity Analysis: Scatter Plot Analysis of DOI Legacy WFP Component Contributions

Legacy WFP element—Legacy WFP was derived from Fire Probability and Fire Behavior sub-elements, as described in Chapter III, Section 1. The legacy WFP element–level results were plotted against overall legacy-based model prioritization results. A strong correlation ($R^2 = 0.91$) was found between the legacy WFP element and overall legacy WFP-based model results, as shown in Figure A3-3.

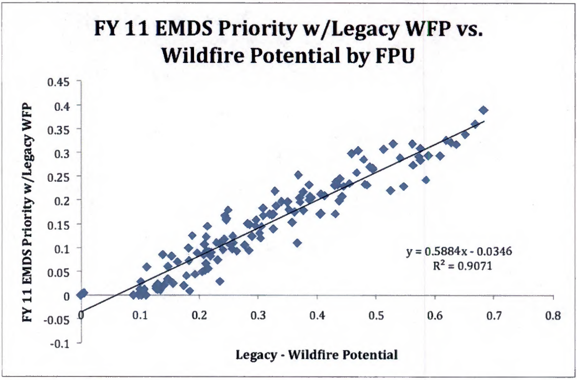


Figure A3-3. Scatter Plot of FY 11 DOI EMDS Legacy WFP-Based Model Results and Legacy WFP Element. Compares with Chapter IV, Figure 12 (LFS-based WFP element plot).

Legacy Fire Probability sub-element—The first of two legacy WFP sub-elements (described in Chapter III, Section 1), the Fire Probability sub-element results were plotted against overall legacy-based model prioritization results. A moderate correlation ($R^2 = 0.79$) was found between the sub-element and overall model results, as shown in Figure A3-4.

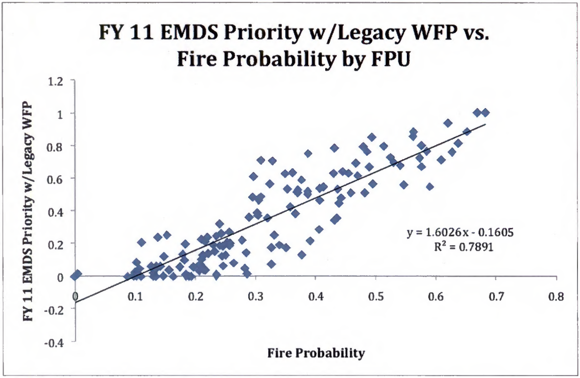


Figure A3-4. Scatter Plot of FY 11 DOI EMDS Legacy WFP-Based Model Results and Legacy Fire Probability Sub-Element

Legacy Fire Behavior sub-element—The second of two legacy WFP sub-elements (described in Chapter III, Section 1), the Fire Behavior sub-element results were plotted against overall legacy-based model prioritization results. A modest correlation (R^2 = 0.39) was found between the sub-element and overall model results, as shown in Figure A3-5.

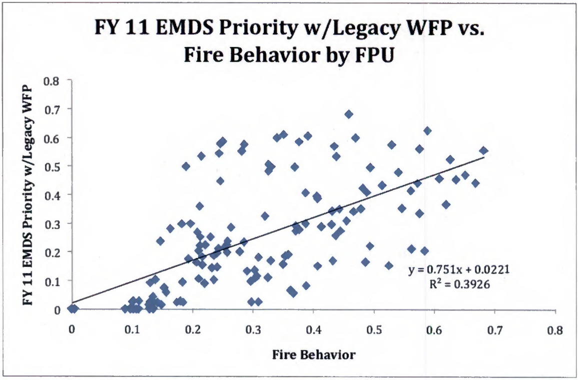


Figure A3-5. Scatter Plot of FY 11 DOI EMDS Legacy WFP-Based Model Results and Legacy Fire Behavior Sub-Element

Negative Consequences element—This second of two top-level elements of the FY 11 model was identical in both the LFS WFP-based final model and the DOI legacy WFP-based model. In this case, the Negative Consequences element–level results were plotted against overall legacy-based model prioritization results. A significant correlation (R^2 = 0.83) was found between the Negative Consequences element and overall legacy WFP-based model results, as shown in Figure A3-6.

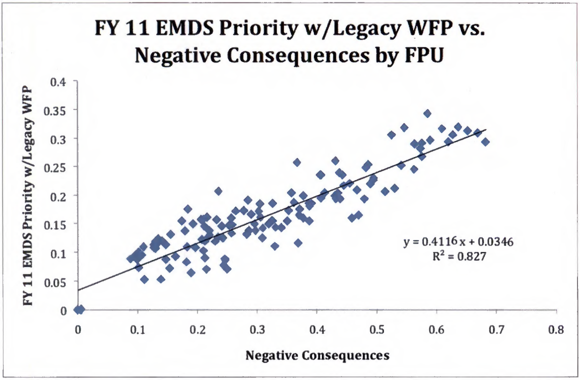


Figure A3-6. Scatter Plot of FY 11 DOI EMDS Legacy WFP-Based Model Results and Negative Consequences Element

Appendix 4

DOI FY 11 EMDS Model Raw FPU Results

This appendix shows the DOI FY 11 EMDS model results for all CONUS FPUs. The LFS WFP-based model (final approved result) is shown on the left side of the table. For comparison and completeness, the DOI legacy WFP-based model is shown on the right. The 10 priority category groups based on natural breaks are shown in colors, consistent with the map graphics in this report. Categories based on quantile breaks are enclosed in heavy black lines.

LFS WFP-Based Model			Legacy WFP-Based Model		
FPU	LFS Rank	LFS Results	FPU	Legacy Rank	Legacy Results
South Central Idaho	1	0.819	Eastern Nevada	1	0.682
Northeast Nevada	2	0.794	Color Country	2	0.669
Color Country	3	0.778	Northeast Nevada	3	0.652
Northwest Nevada	4	0.764	South Central Idaho	4	0.637
Central Wyoming	5	0.752	Southwest Idaho	5	0.627
Eastern Nevada	6	0.748	Southeast Arizona	6	0.62
Northwest Colorado	7	0.742	Pecos Plains	7	0.609
Southeast Oregon	8	0.691	Uintah Basin	8	0.59
Big Horn Basin	9	0.68	Colorado Plateau New Mexico/Arizona	9	0.585
Southeast Arizona	10	0.668	Central Wyoming	10	0.576
Eastern Idaho	11	0.661	Eastern Idaho	11	0.576
Colorado Plateau New Mexico/Arizona	12	0.626	Northwest Nevada	12	0.573
Prairie	13	0.626	Prairie	13	0.563
Ute Mountain/Southern Ute	14	0.602	Northwest Colorado	14	0.562
Central Utah	15	0.593	Big Horn Basin	15	0.547
Western Nevada	16	0.584	Upper Colorado River	16	0.541
Upper Colorado River	17	0.555	Central Oregon	17	0.53
Southern New Mexico Desert	18	0.551	Central New Mexico	18	0.525
South Florida	19	0.547	Northern Utah	19	0.514
Southwest Idaho	20	0.533	NE California and NW Nevada	20	0.495
Central Oregon	21	0.523	Central Coast	21	0.494
Central Nevada	22	0.519	Southeast Utah	22	0.489
Miles City	23	0.504	Miles City	23	0.486
Arizona Strip	24	0.503	Central Nevada	24	0.482
Central Coast	25	0.495	South Florida	25	0.479
Billings	26	0.495	Yosemite Area	26	0.47
Pecos Plains	27	0.477	Western Nevada	27	0.467
San Diego Area	28	0.469	Northwest California	28	0.459

DOI FY 11 EMDS Model Raw FPU Results (continued)

Southeast Utah	29	0.46	Southeast Oregon	29	0.455
Southern Nevada	30	0.46	Central Utah	30	0.445
Northern California	31	0.454	Billings	31	0.443
OCM	32	0.449	Northeast Washington	32	0.439
West Central Arizona	33	0.449	Minnesota Transition and Prairie	33	0.437
Eastern Oregon	34	0.448	Montrose	34	0.435
The Basin	35	0.437	The Desert	35	0.432
Eastern Sierra	36	0.424	Eastern	36	0.431
Greater Yellowstone Area North	37	0.42	San Diego Area	37	0.43
The Desert	38	0.415	Northern California	38	0.413
LA Basin	39	0.399	West Sacramento Valley	39	0.407
Eastern	40	0.397	North Dakota	40	0.407
Gila	41	0.393	Northern New Mexico Mountains	41	0.406
Uintah Basin	42	0.392	Southwest Montana	42	0.391
Lewistown	43	0.388	OCM	43	0.388
Southern Great Plains	44	0.386	Southeast/South Central Oregon	44	0.387
Montrose	45	0.383	Sacramento/Tahoe Area	45	0.387
Northern New Mexico Mountains	46	0.381	White Mountains	46	0.377
Lower Colorado River	47	0.379	Northern Idaho	47	0.377
Central New Mexico	48	0.374	West Central Arizona	48	0.371
Yosemite Area	49	0.373	SE Louisiana/NE Texas Coast	49	0.371
West Sacramento Valley	50	0.354	Southern Sierra	50	0.369
Northeast Washington	51	0.335	Southern New Mexico Desert	51	0.367
Minnesota Transition and Prairie	52	0.331	Western Oklahoma	52	0.362
NE California and NW Nevada	53	0.33	Lewistown	53	0.358
White Mountains	54	0.328	Lower Rio Grande Valley	54	0.353
Riverside Area	55	0.314	Southwest Oregon	55	0.351
Northern Utah	56	0.309	Southern Nevada	56	0.35
SE Louisiana/NE Texas Coast	57	0.295	Central Cascades	57	0.34
Central Arizona	58	0.275	South Front Range	58	0.331
North Dakota	59	0.265	Arizona Strip	59	0.329
Southwest Montana	60	0.262	North Carolina Coast	60	0.326
Southern Sierra	61	0.262	South Carolina/Savannah Coastal	61	0.326
North Carolina Coast	62	0.251	Lower Colorado River	62	0.324
Southeast/South Central Oregon	63	0.241	Southwest Colorado Public Lands	63	0.32
Western Oklahoma	64	0.236	Eastern Oregon	64	0.309
Sacramento/Tahoe Area	65	0.232	Choctaw	65	0.309

DOI FY 11 EMDS Model Raw FPU Results (continued)

Southwest Colorado Public Lands	66	0.228	Northwest New Mexico Plateau	66	0.306
New Jersey	67	0.228	The Basin	67	0.304
Rocky Mountain Front	68	0.224	Riverside Area	68	0.303
Northern Idaho	69	0.223	Creek/Seminole	69	0.297
Black Hills	70	0.22	Ute Mountain/Southern Ute	70	0.296
Lower Rio Grande Valley	71	0.217	Central Arizona	71	0.29
Central Cascades	72	0.213	Coos Bay/Roseburg	72	0.286
Florida Big Bend	73	0.213	Rocky Mountain Front	73	0.285
Helena	74	0.209	Northwest Oregon	74	0.282
North Carolina Piedmont	75	0.209	Mid Plains	75	0.278
Northwest California	76	0.207	Minnesota Woodland	76	0.264
Louisiana Delta	77	0.207	LA Basin	77	0.258
Northeastern	78	0.207	Louisiana Delta	78	0.257
Wallowa-Whitman	79	0.203	SEGA_NEFL	79	0.257
Southwest Oregon	80	0.196	Florida Big Bend	80	0.253
Creek/Seminole	81	0.196	Greater Yellowstone Area North	81	0.25
Central Florida	82	0.192	Northwest Montana	82	0.246
North/Central Louisiana	83	0.186	North Front Range	83	0.246
South Carolina/Savannah Coastal	84	0.181	North Central Washington	84	0.244
Minnesota Woodland	85	0.181	Eastern Sierra	85	0.243
Salmon-Challis	86	0.178	Southern Great Plains	86	0.241
Mid Plains	87	0.177	Salmon-Challis	87	0.241
Northwest New Mexico Plateau	88	0.176	Northeastern	88	0.235
Malheur	89	0.174	Central Florida	89	0.235
Texas Hill Country	90	0.17	Del_Mar_Va	90	0.232
Headwaters	91	0.167	San Luis Valley	91	0.23
Southern Wisconsin	92	0.165	Southern Appalachian	92	0.221
Del_Mar_Va	93	0.164	Black Hills	93	0.22
Northern Appalachian	94	0.163	New Jersey	94	0.216
SEGA_NEFL	95	0.162	Nebraska	95	0.216
Northeast Oregon	96	0.161	Northwest Washington	96	0.215
South Front Range	97	0.159	Headwaters	97	0.213
Northern Wisconsin	98	0.159	Helena	98	0.212
Choctaw	99	0.152	Malheur	99	0.212
Nebraska	100	0.152	Northern Wisconsin	100	0.21
Modoc Plateau	101	0.149	Modoc Plateau	101	0.21
Northeast Texas	102	0.145	Northeast Oregon	102	0.208
Coos Bay/Roseburg	103	0.144	Southern Wisconsin	103	0.206
Central Georgia	104	0.139	Wallowa-Whitman	104	0.197
North Central Washington	105	0.137	North Carolina Piedmont	105	0.193

DOI FY 11 EMDS Model Raw FPU Results (continued)					
Northwest Oregon	106	0.136	North Washington Cascades West	106	0.189
Southern Appalachian	107	0.132	North/Central Louisiana	107	0.184
Iowa	108	0.132	Gila	108	0.183
San Luis Valley	109	0.13	Western Wyoming	109	0.182
Missouri	110	0.126	Texas Hill Country	110	0.179
Pennsylvania	111	0.124	Northern Appalachian	111	0.174
Illinois	112	0.119	Central Coast Range & Cascades	112	0.163
Mississippi	113	0.118	Iowa	113	0.156
Central Coast Range & Cascades	114	0.117	SE Mississippi	114	0.153
Southeast Texas	115	0.114	Northeast Texas	115	0.148
Indiana	116	0.114	UP of Michigan	116	0.147
Eastern Arkansas	117	0.11	Central Georgia	117	0.142
Northwest Montana	118	0.109	South Texas Coast	118	0.138
LP of Michigan	119	0.108	Missouri	119	0.135
West Virginia	120	0.108	Mississippi	120	0.135
North Front Range	121	0.101	Pennsylvania	121	0.134
Southern Ozarks	122	0.096	Illinois	122	0.13
Tennessee-Green Rivers	123	0.095	LP of Michigan	123	0.13
Western Wyoming	124	0.09	Southeast Texas	124	0.128
UP of Michigan	125	0.09	Indiana	125	0.127
Cumberland	126	0.089	Southwest Texas	126	0.111
Ohio	127	0.088	Eastern Arkansas	127	0.11
Southwest Texas	128	0.082	Southern Ozarks	128	0.107
SE Mississippi	129	0.076	West Virginia	129	0.102
Alabama/Florida Panhandle	130	0.074	Alabama/Florida Panhandle	130	0.102
South Texas Coast	131	0.073	Cumberland	131	0.1
Northwest Washington	132	0.072	Tennessee-Green Rivers	132	0.097
North Washington Cascades West	133	0.067	Ohio	133	0.088
Pacific Islands	134	0.001	Pacific Islands	134	0.005
Caribbean	135	0	Caribbean	135	0.004
Bitterroot	136	0	Bitterroot	136	0

Appendix 5

DOI FY 11 EMDS Sensitivity Tables and Discussion

The first of two sensitivity assessments using EMDS sensitivity tables was done for FPUs directly. Considering that 136 FPUs were evaluated in the FY 11 analysis, this approach was applied to the top-20 ranked FPUs in the interest of brevity and owing to the general lack of significant sensitivity for information below that level. A second approach was to perform a similar assessment of sensitivity among the 10 priority classes (FPU groups) that were categorized in the EMDS analysis for HFPAS use.

The tabular results of each of these assessments are intended to provide insight into the model's robustness—that is, in this report, the sensitivity of prioritization results. An outcome is considered robust if a substantial change would be required in the designated model criterion to alter a given result. Empirical experience with EMDS suggests a change threshold of 10 percent or greater is indicative of robustness. Conversely, a result is not robust if a minor change (less than 10 percent) in the identified criterion would alter an outcome. Robustness and sensitivity are effectively opposite concepts: a model element that is robust is insensitive, whereas an element that is sensitive indicates a lack of robustness.

In the past several DOI EMDS analyses, the models have been composed of four top-level elements, generally with several sub-elements in each, and model components have been differentially weighted across the model at all levels. Furthermore, past analyses have been applied to small numbers of units (for example, a few Bureaus, geographic areas, or regions). In comparison, the nature of the FY 11 model structure tends to limit both the degree of separation among FPUs and the utility of these standard EMDS sensitivity tables.

A primary factor in this limitation is the coequal weighting of the two top-level elements and also the two sub-elements under Negative Consequences (see Table 1). As a result, the sensitivity tables present a pair of most sensitive criteria in every case rather than a single, unambiguous most sensitive criterion. Absent prior experience with such a model, an unforeseen but also unsurprising result of this pervasive coequal weighting—in conjunction with only two top-level elements applied to 136 FPUs—is a lack of

robust separation of FPUs in a preponderance of cases (see Section A below). On the other hand, this result suggests the utility of establishing and using priority *categories* in the final results for HFPAS application, rather than raw ranks. The separation of categories *is* shown to be robust in the associated sensitivity table (see Section B below).

A. FPU Rank Sensitivity

The DOI FY 11 EMDS FPU rank sensitivity results are shown in Table A5-1 and are interpreted as follows: It would require a 24.8 percent change in either the Human Impacts or the Ecosystem Impacts sub-element (or that amount of total change cumulatively between the two) for the results to be altered, in which case the South Central Idaho FPU would be supplanted by the Northeast Nevada FPU as the top priority unit. Similarly, if South Central Idaho was removed from the analysis, a 22.8 percent change would be required in either the Ecosystem Vulnerability or the Non-Native Species node (or that amount of total change cumulatively between the two) for Color Country to supersede Northeast Nevada in priority rank—and so forth.

Note: All sensitivity analysis tables in this report may be interpreted in the manner just described.

Table A5-1. DOI FY 11 EMDS Sensitivity Analysis Table, Top 20 FPUs (LFS WFP-based results)

FPU Name	Rank	Most Sensitive Criteria (tied)	% Change To Replace	Replacing FPU
South Central Idaho	1	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	24.8	Northeast Nevada
Northeast Nevada	2	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	22.8	Color Country
Color Country	3	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	13.4	Northwest Nevada
Northwest Nevada	4	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	5.4	Central Wyoming
Central Wyoming	5	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	2.1	Eastern Nevada
Eastern Nevada	6	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	2.9	Northwest Colorado
Northwest Colorado	7	Goal—Wildfire Potential Goal—Negative Consequences	15	Southeast Oregon
Southeast Oregon	8	Goal—Wildfire Potential Goal—Negative Consequences	2.7	Big Horn Basin
Big Horn Basin	9	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	5.8	Southeast Arizona
Southeast Arizona	10	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	2.4	Eastern Idaho
Eastern Idaho	11	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	8.5	Colorado Plateau New Mexico/Arizona
Colorado Plateau New Mexico/ Arizona	12 (tie)	Goal—Wildfire Potential Goal—Negative Consequences	0	Ute Mountain/ Southern Ute
Prairie	12 (tie)	Goal—Wildfire Potential Goal—Negative Consequences	0	Ute Mountain/ Southern Ute
Ute Mountain/ Southern Ute	13	Goal—Wildfire Potential Goal—Negative Consequences	3.4	Central Utah
Central Utah	14	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	9.8	Western Nevada
Western Nevada	15	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	8.5	Upper Colorado River
Upper Colorado River	16	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	1.1	Southern New Mexico Desert
Southern New Mexico Desert	17	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	1.6	South Florida
South Florida	18	Goal—Wildfire Potential Goal—Negative Consequences	2.9	Southwest Idaho
Southwest Idaho	19	Goal—Wildfire Potential Goal—Negative Consequences	2.8	Central Oregon
Central Oregon	20	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	1.3	Central Nevada

At the 10 percent threshold, Table A5-1 shows that the top three FPUs are robustly prioritized by the model but also that, with the exception of the 7th ranked Northwest Colorado FPU, the model rankings are generally not robust and are sensitive to relatively minor changes in the indicated portions of the model. Since the two FPUs at the 12th position are ranked identically, they are both able to be replaced by the 13th ranked FPU with a change of 3.4 percent.

As noted above, a considerable interpretive challenge is posed by the "% Change To Replace" metric, given that the most sensitive criteria are always paired for this model and given that the total change could occur in either criterion or be split between both listed criteria. The model structure also results in some of the criteria pairs occurring at the top element level of the model (for example, ranks 7 and 8), meaning that changes in any subordinate component anywhere in the model could yield a ranking change—a situation that is not at all illuminating. In some cases (for example, ranks 9–11) the identified criteria consist of simply the fundamental physical attributes of DOI area and proportion inputs to the model, and as such do not provide insight into sensitivities in the underlying model design.

B. Ten-Category Sensitivity

Notwithstanding the raw FPU priority ranks, priority *categories* based on natural breaks are the basis for use of EMDS results in the DOI HFPAS process. The preceding discussion reinforces the need for an alternative to raw FPU scores for this purpose. Consequently, a standard assessment of sensitivity among categories was of interest. A representative FPU with a central score within each category was used for this approach, and the result is shown in Table A5-2. Notwithstanding the representative FPUs, the interpretation is that unidentified specific FPUs would begin to move between the respective categories at the indicated change threshold.

Table A5-2. DOI FY 11 EMDS Sensitivity Analysis Table, 10 Priority Categories (LFS WFP-based results)

Category	Representative FPU	Most Sensitive Criteria (tied)	% Change To Replace	Replacing Category	Representative Replacing FPU
1	Central Wyoming	Goal—Wildfire Potential Goal—Negative Consequences	48.8	2	Central Utah
2	Central Utah	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	20.1	3	San Diego Area
3	San Diego Area	Goal—Wildfire Potential Goal—Negative Consequences	14.3	4	Uintah Basin
4	Uintah Basin	Goal—Wildfire Potential Goal—Negative Consequences	22.9	5	Riverside Area
5	Riverside Area	Goal—Wildfire Potential Goal—Negative Consequences	31.6	6	Northern Idaho
6	Northern Idaho	Goal—Wildfire Potential Goal—Negative Consequences	27.3	7	Headwaters
7	Headwaters	WUI Impact—WUI Impact Proportion WUI Impact—WUI Impact Area	40.4	8	Pennsylvania
8	Pennsylvania	Goal—Wildfire Potential Goal—Negative Consequences	21.1	9	Southwest Texas
9	Southwest Texas	Goal—Wildfire Potential Goal—Negative Consequences	100	10	Bitterroot
10	Bitterroot	N/A	100	N/A	N/A

In this case, robust prioritization differences between categories are uniformly present. The separation between the first two categories is extremely robust, whereas the difference between categories 3 and 4 is shown to be least robust. Furthermore, the results are intuitively hierarchical, with indicated change thresholds leading to succession in exact categorical order. Nevertheless, the interpretative ambiguities and challenges related to paired criteria and sensitivity at the very highest and very lowest levels of the model remain.

C. Legacy WFP-Based Analysis Sensitivity Tables

For the legacy-based analysis (described in Appendix 3), the following FPU and category sensitivity tables were generated (Figures A5-3 and A5-4, respectively). The interpretations and issues associated with these tables are similar to those previously described for the LFS-based model.

Table A5-3. Sensitivity Analysis Table, Top 20 FPUs (Legacy WFP Model)

FPU Name	Rank	Most Sensitive Criteria (tied)	% Change To Replace	Replacing FPU
Eastern Nevada	1	Goal—Wildfire Potential Goal—Negative Consequences	15.1	Color Country
Color Country	2	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	24.3	Northeast Nevada
Northeast Nevada	3	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	15	South Central Idaho
South Central Idaho	4	Human Impacts—Infrastructure Impacts Human Impacts—WUI Impacts	15.4	Southwest Idaho
Southwest Idaho	5	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	4.5	Southeast Arizona
Southeast Arizona	6	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	6.4	Pecos Plains
Pecos Plains	7	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	11.9	Uintah Basin
Uintah Basin	8	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	1.5	Colorado Plateau New Mexico/Arizona
Colorado Plateau New Mexico/Arizona	9	Goal—Wildfire Potential Goal—Negative Consequences	3.2	Eastern Idaho
Central Wyoming	10 (tie)	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	0.1	Northwest Nevada
Eastern Idaho	10 (tie)	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	0.1	Northwest Nevada
Northwest Nevada	11	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	5	Prairie
Prairie	12	Goal—Wildfire Potential Goal—Negative Consequences	0.5	Northwest Colorado
Northwest Colorado	13	Goal—Wildfire Potential Goal—Negative Consequences	4.9	Big Horn Basin
Big Horn Basin	14	Goal—Wildfire Potential Goal—Negative Consequences	2.1	Upper Colorado River
Upper Colorado River	15	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	6.1	Central Oregon
Central Oregon	16	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	1.2	Central New Mexico
Central New Mexico	17	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	3	Northern Utah
Northern Utah	18	Ecosystem Impacts—Non-Native Species Ecosystem Impacts—Ecosystem Vulnerability	9.7	NE California and NW Nevada
NE California and NW Nevada	19	Wildfire Potential—LFS Area Wildfire Potential—LFS Proportion	0.2	Central Coast
Central Coast	20	Negative Consequences—Human Impacts Negative Consequences—Ecosystem Impacts	2	Southeast Utah

Table A5-4. Sensitivity Analysis Table, 10 Priority Categories (Legacy WFP Model)

Category	Representative FPU	Most Sensitive Criteria (tie)	% Change To Replace	Replacing Category	Representative Replacing FPU
1	Southeast Arizona	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	47	2	NE California and NW Nevada
2	NE California and NW Nevada	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	42	3	Montrose
3	Montrose	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	28	4	SE Louisiana/NE Texas Coast
4	SE Louisiana/NE Texas Coast	WUI Impact—WUI Impact Proportion WUI Impact—WUI Impact Area	33.2	5	Lower Colorado River
5	Lower Colorado River	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	18.1	6	Minnesota Woodland
6	Minnesota Woodland	WUI Impact—WUI Impact Proportion WUI Impact—WUI Impact Area	22.9	7	Del_Mar_Va
7	Del_Mar_Va	Goal—Wildfire Potential Goal—Negative Consequences	27.4	8	Wallowa-Whitman
8	Wallowa-Whitman	Wildfire Potential—Fire Probability Wildfire Potential—Fire Behavior	31.1	9	South Texas Coast
9	South Texas Coast	Goal—Wildfire Potential Goal—Negative Consequences	18	10	Cumberland
10	Cumberland	Goal—Wildfire Potential Goal—Negative Consequences	100	N/A	N/A